Iron and Steel ENGINEER

ENGINEERING SERVICE TO THE IRON AND STEEL INDUSTRY SINCE 1907

MAY, 1953

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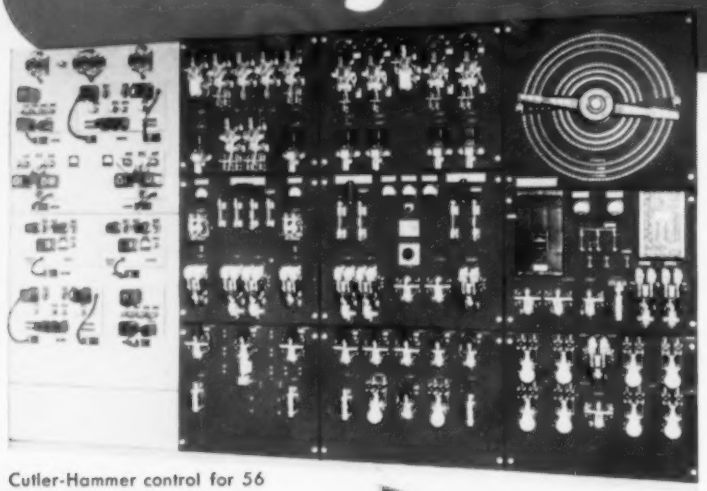
MAY 26 1953
DETROIT

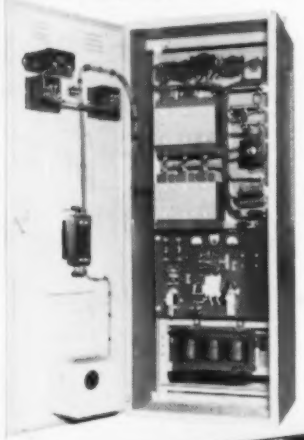
The Wean ENGINEERING COMPANY, Inc.
WARREN OHIO

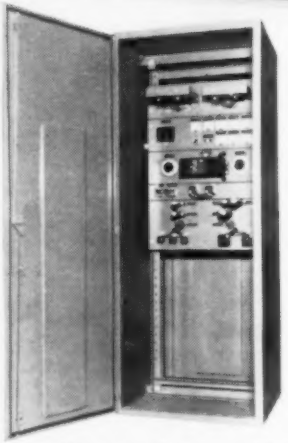
Nothing succeeds like success!



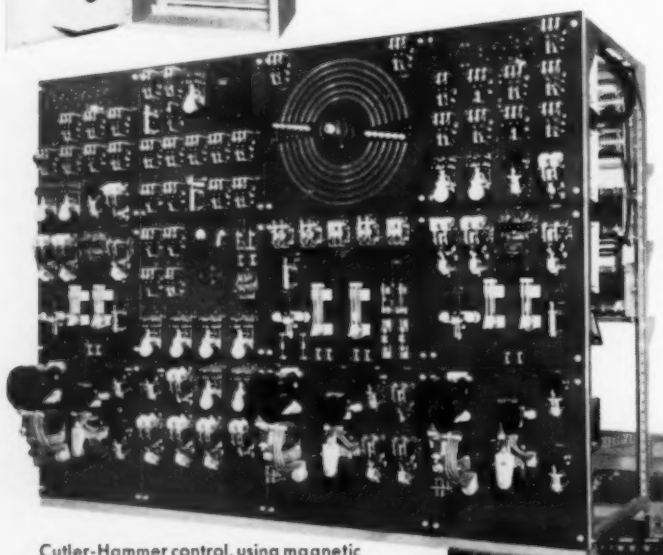
Cutler-Hammer control for 56 inch side trimming and shear line using magnetic amplifier.

Cutler-Hammer high frequency control for electric welding tube mill, using magnetic amplifier.

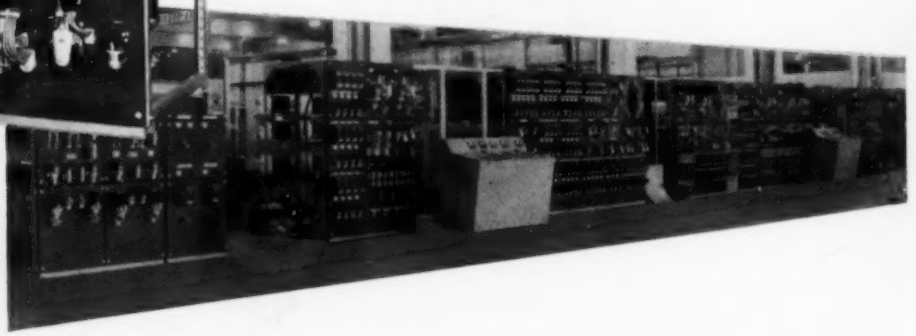




Cutler-Hammer magnetic amplifier speed regulator for a large tube mill.



Cutler-Hammer control, using magnetic amplifier, for reversing cold strip mill with tension and voltage regulation.



Cutler-Hammer D-C Controllers using magnetic amplifier for pipe mill in a southwestern steel mill.

Cutler-Hammer's experience in applying the Magnetic Amplifier to steel mill control assures correct solution of your problems.

Cutler-Hammer has been so successful in the past in applying the magnetic amplifier to steel mill control schemes, it is very natural that companies looking for best results should come to Cutler-Hammer.

This further adds to Cutler-Hammer's backlog of experience, and gives more positive assurance that the control scheme will properly apply and utilize all the inherent advantages of this dependable control component that has no moving parts, is capable of split-second response and many amazing features. . . . Nothing succeeds like success! CUTLER-HAMMER, Inc., 1269 W. St. Paul Ave., Milwaukee 1, Wis. *Associate:* Canadian Cutler-Hammer, Ltd., Toronto, Ontario.

CUTLER-HAMMER
MOTOR CONTROL
C-H

IRON AND STEEL ENGINEER: published monthly by Association of Iron and Steel Engineers, 1010 Empire Bldg., entered as second class matter January 25, 1924 at Pittsburgh, Pennsylvania under Act of Congress, March 3, 1879. $7.50 per year in United States and Canada, $10.00 foreign countries. Volume 30, No. 5.

GOOD EQUIPMENT BRINGS DOWN PRODUCTION COSTS

continuous

buttweld pipe mills

The expansion of the steel industry has been marked by great demand for Continuous Butt Weld Pipe Mills from Aetna-Standard. Recent installations include two mills in the new Fairless Works for ½" to 4" and one mill for Sharon Tube for ¼" to ⅛" sizes.

Most of the Continuous Butt Weld Pipe Mills around the world carry the name of Aetna-Standard. Aetna designs, engineers and builds the mills complete from coil storage through shipping department . . . and supervises installation.

THE AETNA-STANDARD ENGINEERING COMPANY • PITTSBURGH, PA.

Aetna-Standard

PLANTS IN WARREN, OHIO • ELLWOOD CITY, PENNSYLVANIA

ASSOCIATED COMPANIES

Head Wrightson Machine Company, Ltd., Middlesbrough, England — Great Britain, Finland, Sweden, Norway, Denmark, Union of South Africa, Northern and Southern Rhodesia.

Aetna-Standard Engineering Company, Ltd., Toronto, Ontario, Canada.

M. Costello, Inc., New York, N. Y. — Mexico, Central and South America.

Société de Constructions de Montbard, Paris, France — France, Belgium, Holland, Luxembourg, Switzerland.

Demag Aktiengesellschaft, Duisburg, Germany — Germany, Austria, Yugoslavia, Greece, Turkey, Egypt.

Compagnia Italiana Forme Acciaio, Milano, Italy — Italy.

Aetna-Japan Company, Ltd., Tokyo, Japan — Japan.

Hale & K-Boren, Inc., Akron, Ohio — Representative for the Rubber Industry.

Designers and Builders to the Ferrous, Non-Ferrous, Leather and Rubber Industries

Cities Service Cutting Oils Proved The Very Best By Micrometer Test!

CUTTER MEASURED WITH MICROMETER. As a final test, Automatic Pencil Sharpener measures each cutter with a micrometer. All tests proved that Cities Service cutting oil was absolutely tops for this really tough job.

STRICT SPECIFICATIONS REQUIRE FINEST CUTTING OIL. APSCO Sharpeners offer many more features than other brands. To produce their top quality product, Spengler-Loomis relies on top-quality lubrication products . . . Cities Service Products, famous throughout industry.

ONLY .005 INCHES BURR OR BUILD-UP ALLOWED IN FIFTY-HOUR OPERATION CUTTING GROOVE IN B1112 STEEL!

Says Mr. C. J. Kostrzewa, Plant Superintendent: "Cutting oil requirements in our Automatic Pencil Sharpener Division are tough. To find the right coolant, we called for, and tested, samples from various companies. Over a period of testing time, we used graphs, charts and tables, keeping a running record on all coolants. As a final test, we measured the cutter with a micrometer before and after milling. The cutting oil that came out tops was Cities Service.

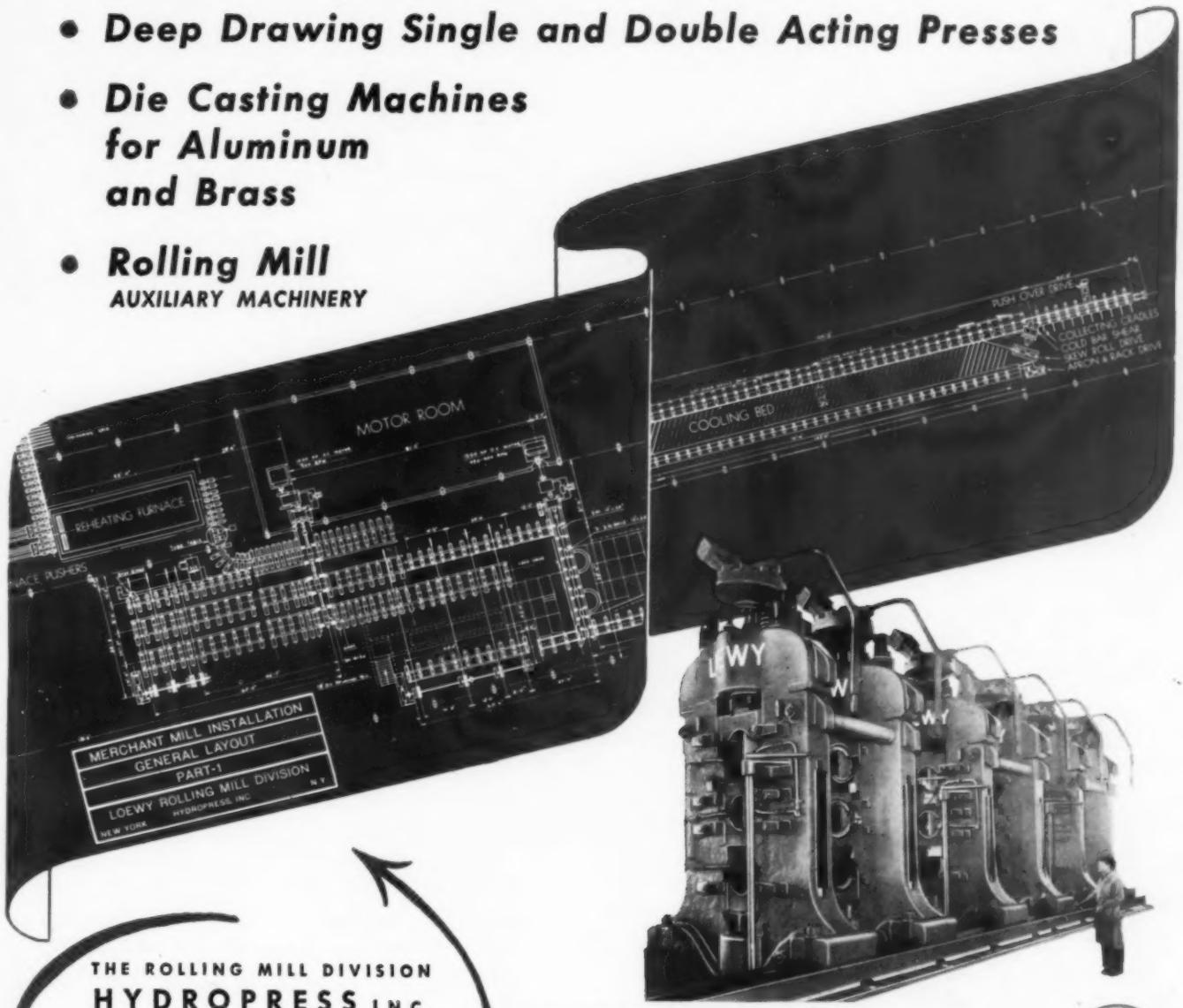
"I'd also like to point out that the Cities Service Engineering staff co-operated fully by offering helpful advice and excellent service."

Why not discuss your lubrication problems with a Cities Service lubrication engineer? Write Cities Service Oil Company, Dept. E-11, Sixty Wall Tower, New York 5, New York—or contact your nearest Cities Service office.

CITIES SERVICE
QUALITY PETROLEUM PRODUCTS

We Build Complete Rolling Mill Installations

- ***Hot and Cold Rolling Mills for Ferrous and Non-Ferrous Metals*** SHEARS, LEVELLERS, STRAIGHTENERS, COILERS, ETC.
- ***Extrusion Plants for Steel*** AND NON-FERROUS METALS
- ***Forging and Die Forging Plants***
- ***Deep Drawing Single and Double Acting Presses***
- ***Die Casting Machines for Aluminum and Brass***
- ***Rolling Mill*** AUXILIARY MACHINERY



THE ROLLING MILL DIVISION
HYDROPRESS INC.
will put into operation in 1953 a steel mill installation for the National Shipyards and Steel Corporation in Manila

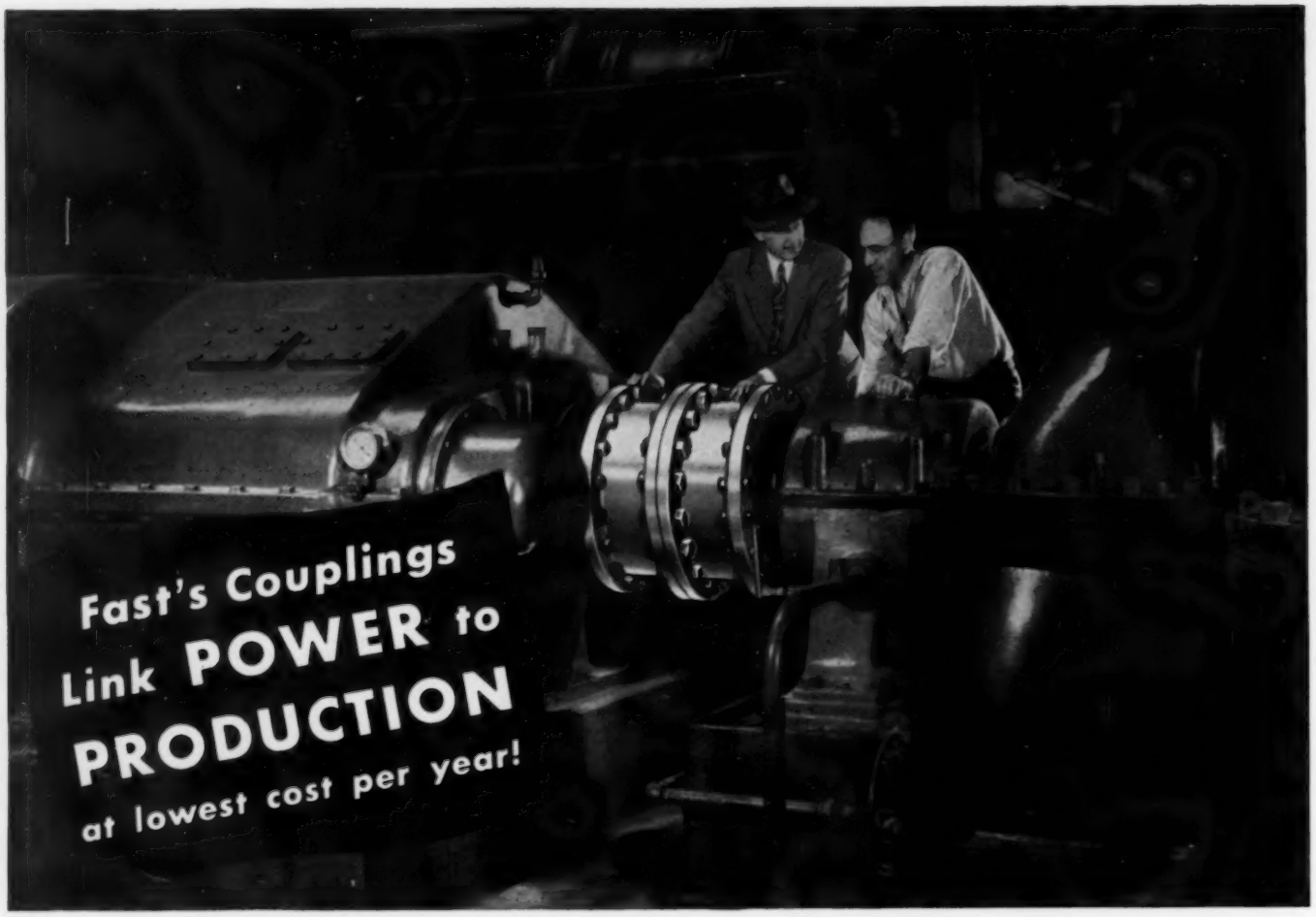
LOEWY ROLLING MILL DIVISION

HYDROPRESS INC.
ENGINEERS • CONTRACTORS

Birmingham • Chicago • Cleveland • Detroit • Los Angeles • Phoenix • San Francisco
Seattle • Washington, D. C. • Wheeling
Genoa, Italy • London, England • Madrid, Spain • Paris, France • Philippine Islands

Rolling Mills • Hydraulic Presses • Pipe Testing Machines • Special Pipe Mill Equipment • Accumulators • Pumps • Die Casting Machines

350-G Fifth Avenue, NEW YORK 1, N. Y.



Over half a million FAST'S Couplings now in use!

THROUGHOUT industry, Fast's are rated the most dependable couplings on the market . . . to the tune of over half a million now in service! Year in, year out, they continue to *outlast the equipment they connect* . . . save time, maintenance and money by eliminating costly coupling failures.

Actual cases on record show many Fast's Couplings have been in operation for 25 and 30 years without trouble. And every major producer of high-speed equipment now uses Fast's!

Solve your coupling worries! Write today for full details on Fast's Couplings and Koppers Engineering Service to: KOPPERS COMPANY, INC., *Fast's Coupling Dept.*, 215 Scott St., Baltimore 3, Maryland.

Here's How FAST'S Save You Money

Free Service—Koppers free engineering service assures you the right coupling for the job.

Rugged Construction—Fast's still maintains its original design, without basic change or sacrifice in size or materials. Result: freedom from expensive coupling failures.

Lowest Cost per Year—Fast's Couplings usually outlast equipment they connect. Their cost may be spread over many years!

KOPPERS®

FAST'S
THE ORIGINAL
GEAR-TYPE
Couplings

INDUSTRY'S STANDARD FOR 32 YEARS

KOPPERS COMPANY, INC., *Fast's Coupling Dept.*
215 Scott St., Baltimore 3, Md.

Gentlemen: Send me Fast's Catalog which gives detailed descriptions, engineering drawings, capacity tables and photographs.

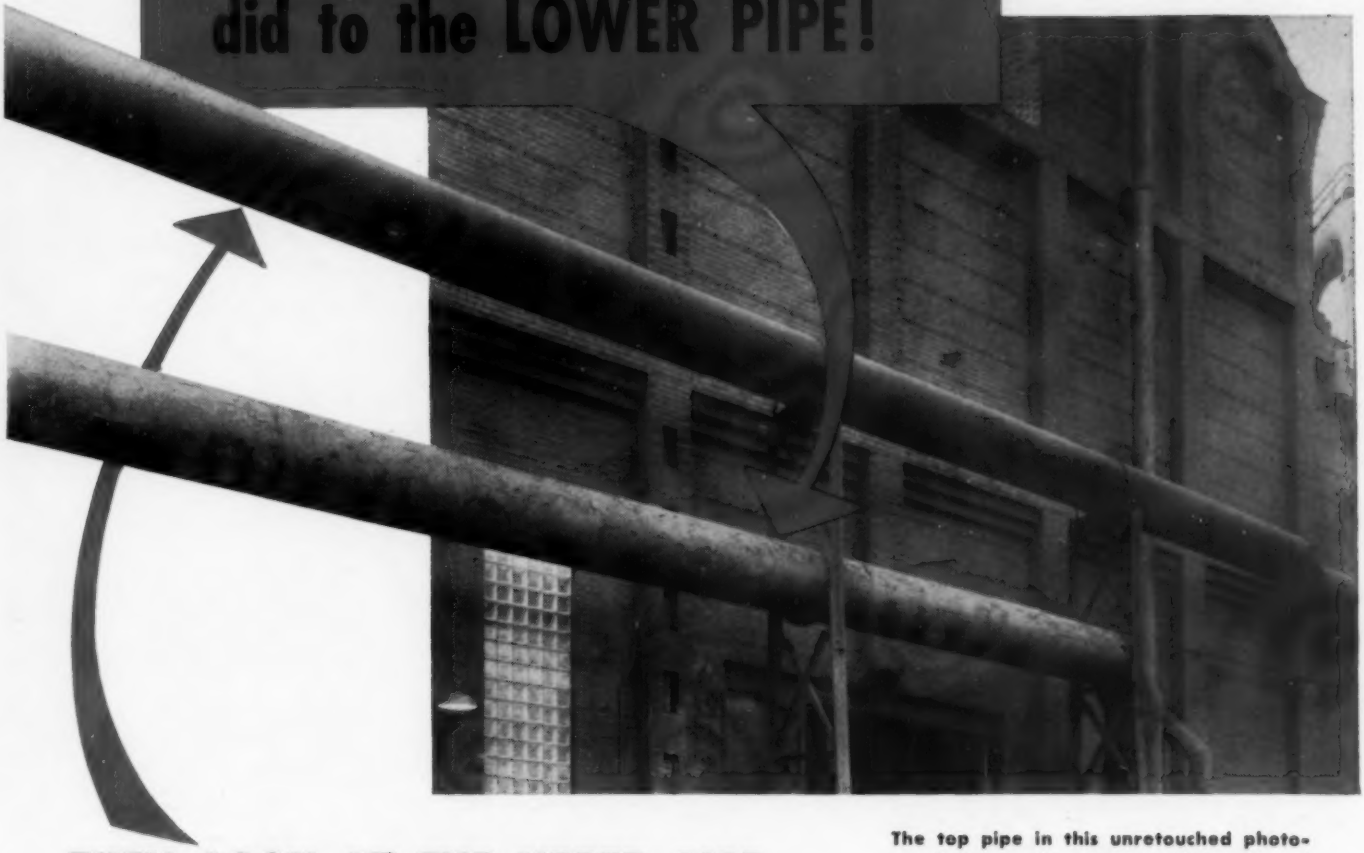
Name .....

Company .....

Address .....

City ..... *Zone* ..... *State* .....

Look what coke quenching did to the LOWER PIPE!



THEN LOOK AT THE UPPER PIPE *completely protected* BY INSUL-MASTIC

The top pipe in this unretouched photograph has a three year old coating of INSUL-MASTIC, the *Superior* protective coating. The bottom pipe has been painted several times during those three years. These pipes are in a steel mill and both are constantly showered with acid vapors from a coke quenching tower which is around the corner of the building. So strong are the vapors that they sting the faces and arms of workmen, but three years of this punishment have not harmed the INSUL-MASTIC coated pipe.

Steel mills throughout the country are learning that INSUL-MASTIC lasts for years and years and practically eliminates maintenance and replacement of metal equipment. These coatings are extremely resistant to acids, alkalis and moisture. They are specially made that way. The generous use of Gilsonite, one of nature's most chemically resistant minerals, helps give this lasting protection.

Save your tanks, structural steel, pipes, quench cars and everything on or near your coke batteries. Do as other mills are doing. Specify INSUL-MASTIC for coating this equipment.

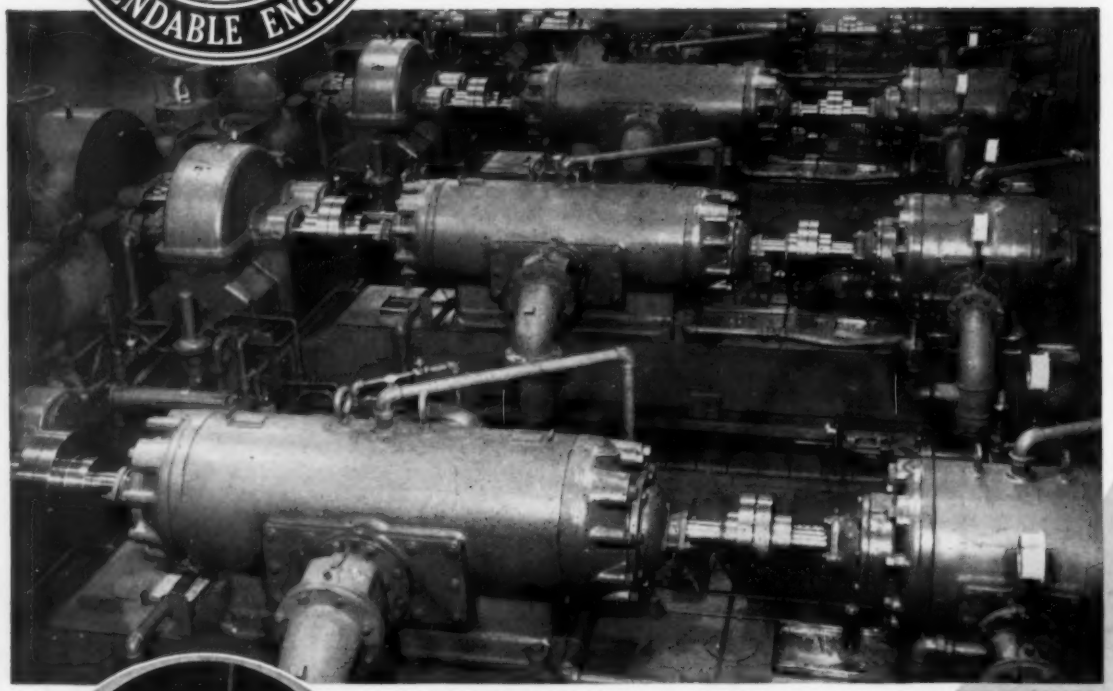
There is an INSUL-MASTIC representative near you. ★★★ Write for his name!

Think First of the Coatings that last!

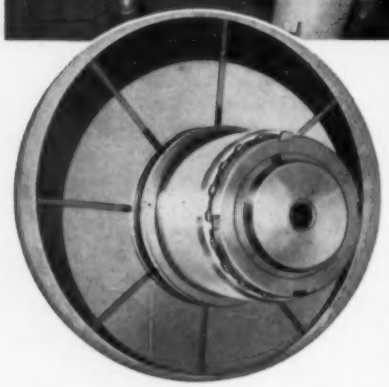
Insul-Mastic

CORPORATION OF AMERICA
Oliver Building • Pittsburgh 22, Pa.
Representatives in Principal Cities

PRATT & WHITNEY AIRCRAFT



Four Fuller Rotary Compressors, Elliott steam-turbine driven, have a total capacity of 6760 c.f.m., at 110 p.s.i.



depends on FULLER AIRPOWER

Four Fuller Rotary Two-stage Compressors put Pratt & Whitney Aircraft's engine plant in East Hartford on a 100 p.s.i. air diet for such operations as shot peening, spray booths, air cleaning, and air-operated chucks.

Pratt & Whitney Aircraft has joined no *small* family of users; food and chemical plants, steel mills and cement mills, gas-gathering plants, refineries, automobile plants, foundries and machine shops, public utilities, and many others depend on Fuller for compressor equipment, wherever air is required.

Whether *your* air-plans call for single-stage, two-stage — single-stage duplex or two-stage duplex—you can be sure Fuller has the compressors which gives you a dependable source of pulsation-free air up to 3300 c.f.m., 125 p.s.i., with maintained capacity for the life of the machine.

Write for Bulletin C-6, Fuller Rotary Compressors.

FULLER COMPANY, Catasauqua, Pa.
Chicago 3—120 So. LaSalle St.
San Francisco 4—420 Chancery Bldg.

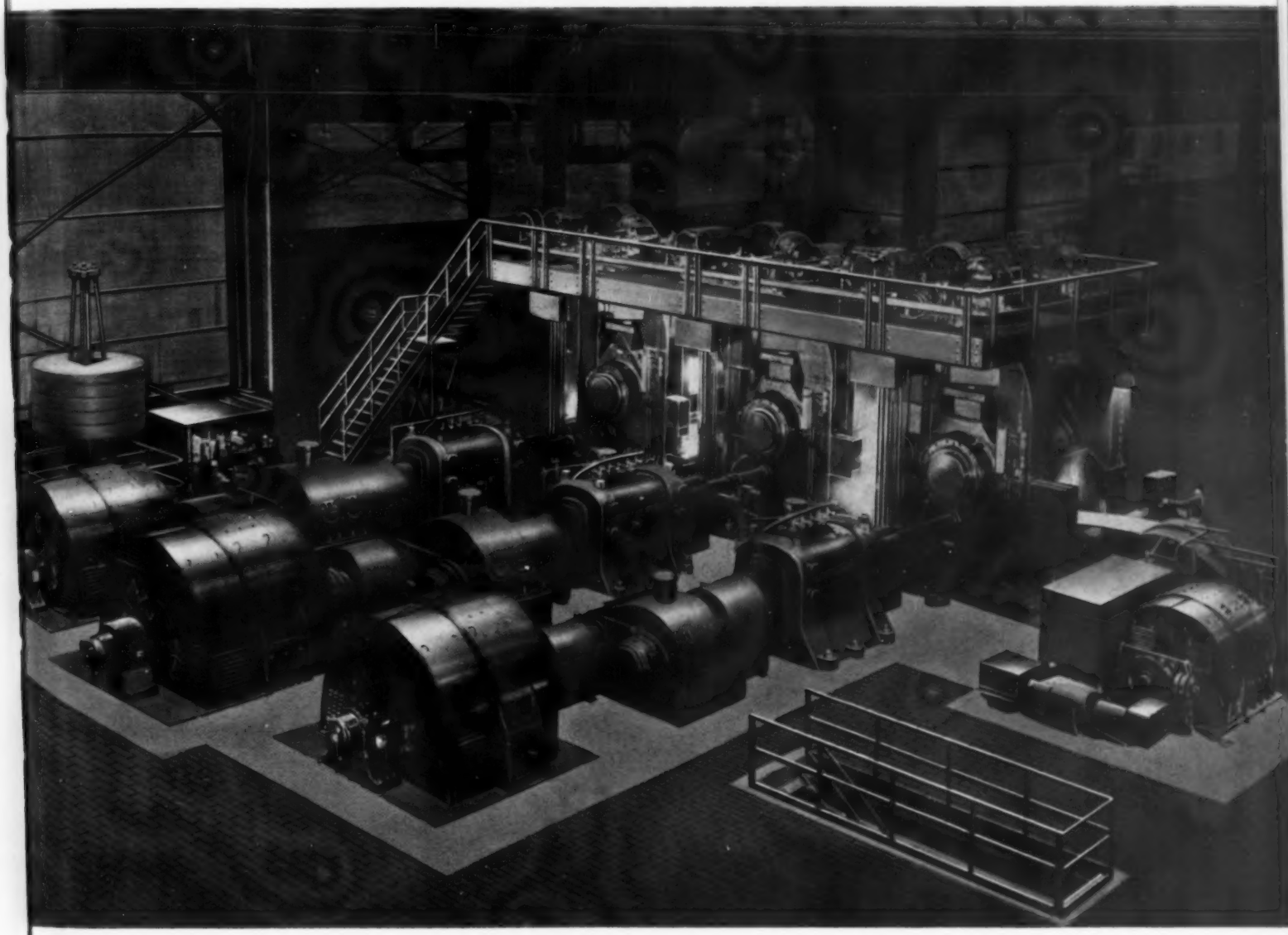
Fuller

PIONEERS OF HIGH-EFFICIENCY VANE-TYPE ROTARY COMPRESSORS

C-225
1624

CONTINENTAL

80-Inch TANDEM COLD STRIP MILL



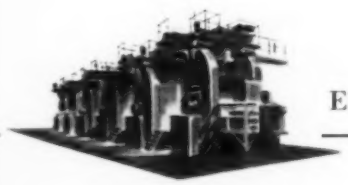
Complete Rolling Mill Installations

SLABBING MILLS	Mills complete with Auxiliary Equipment	BLOOMING MILLS
UNIVERSAL MILLS		STRUCTURAL MILLS
PLATE MILLS	★ ★ ★	RAIL MILLS
HOT STRIP MILLS	CONTINENTAL CHIPPER	BILLET MILLS
COLD STRIP MILLS	ROLL LATHES	ROD MILLS
TEMPER MILLS	SPECIAL MACHINERY	MERCHANT MILLS

CASTINGS—carbon and alloy steel from 20 to 250,000 pounds

ROLLS—iron, alloy iron and steel rolls for all types of rolling mills

WELDMENTS—fabricated steel plate, or cast-weld design.



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Foundry & Machine
Company

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—an Outstanding Feature of HAGAN Air-Operated Controls and Ring Balance Flow Meters

- Heat Input Control
- Fuel-Air Ratio Control
- Furnace Pressure Control
- Gas Pressure Control
- Gas Mixing Control
- Flow Meters for gas, steam, water, and compressed air
- Draft and Pressure Recorders
- Btu Meters for mixed fuels
- Control of multiple fuel firing
- Reversal Control

The production of steel presents complex metering and control problems. Wherever steel is made, Hagan Air-Operated Combustion Controls and Ring Balance Flow Meters solve them smoothly and efficiently. Simply designed and ruggedly built, Hagan equipment combines the utmost in reliability and accuracy, with a minimum of maintenance and operating expense. Applicable to all phases of the steel industry, Hagan Controls and Meters assure dependable service.

Experienced Hagan Engineers are ready to help you solve your steel mill metering and control problems. For information, write, wire, or phone:

HAGAN CORPORATION

HAGAN BUILDING, PITTSBURGH 30, PA.

BOILER COMBUSTION CONTROL SYSTEMS
RING BALANCE FLOW AND PRESSURE INSTRUMENTS
METALLURGICAL FURNACE CONTROL SYSTEMS
CONTROL SYSTEMS FOR AERONAUTICAL
AND AUTOMOTIVE TESTING FACILITIES

FARRELL -CHEEK

SPROCKETS

✓ WEAR-RESISTANT

✓ ACCURATE

✓ DURABLE

✓ RIGID

Finest Name in Cast Steel!

FARRELL-CHEEK STEEL CO.

MANUFACTURERS OF HIGHEST QUALITY ELECTRIC FURNACE CARBON AND ALLOY STEEL CASTINGS

FARRELL'S CARBON STEEL CASTINGS
FARRELL'S HARD EDGE STEEL CASTINGS
FARRELL'S "85" STEEL CASTINGS

RAILROAD CASTINGS
Locomotive and Car
R. R. Specialty Castings.

ELEVATOR, CONVEYOR PARTS
Sprockets, Traction Wheels, Chains, Buckets, Rollers, Idlers.

BUSHINGS
Carbon and Alloy Steels Machined, Hardened, Ground.

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GEARS AND PINIONS
"True Tooth" Gears and Pinions, Sheaves and Wheels.

SPECIALIZED CASTINGS
Light Section Castings.

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Feed Screws, Furnace Tools, Flanged Pipe, etc.

HEAVY HARDWARE
Wire Rope Fittings, Choker Hooks, Bar Benders, Cutters.

YOUR INQUIRY WILL PROMPTLY BRING DETAILED INFORMATION PERTAINING TO ANY OF THE ABOVE FARRELL-CHEEK PRODUCTS

• • • SANDUSKY, OHIO U.S.A.

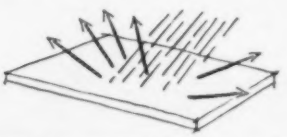
the practical answer to your rust problems indoors and out . . . . . so easy to use that one man often does the work of two.

FACTS

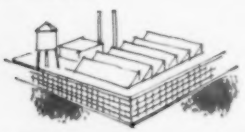
prove the economy of Rust-Oleum

Apply Directly Over Sound Rusted Surfaces—Brush Rust-Oleum 769 Damp-Proof Red Primer *directly* over *sound rusted surface* after scraping and wire-brushing to remove rust scale and loose rust. Sand-blasting, chemical pre-cleaning and other costly preparation methods are *not* usually required.

Available In Many Colors, Aluminum, and White, Brush, Dip, or Spray—Get *double protection*. Beautify as you protect with Rust-Oleum finish coats in the color of your choice.



Practical, Economical Answer To Your Rust Problem—Rust-Oleum resists rain, heat, fumes, sun, salt air, salt spray, and many chemicals—as well as condensation indoors.



Proved Throughout Industry For Over 25 Years—On tanks, girders, pipes, machinery, roofs, buildings, fences, stacks, throughout industry — Rust-Oleum has *proved* its capacity to stop rust for over *25 years*.

RUST-OLEUM®

STOPS RUST!

Rust-Oleum *cuts costly manhours!* Just scrape and wirebrush to remove rust scale and loose rust . . . then brush Rust-Oleum 769 Damp-Proof Red Primer *directly over the sound rusted surface*. Rust-Oleum finish coatings available in many colors, aluminum, and white give you *double protection*. Sandblasting and other costly preparations are *not* usually required. Specify Rust-Oleum . . . prompt delivery from Industrial Distributor stocks in principal cities.

Resists Rain, Snow, Heat, Fumes, Weathering, Salt Water, etc.

RUST-OLEUM CORPORATION
2445 Oakton Street, Evanston, Illinois

FREE SURVEY: Ask a Rust-Oleum specialist to conduct a survey including actual applications, tests, and recommendations. No cost or obligation. See Sweets for nearest Rust-Oleum distributor or write for literature today.

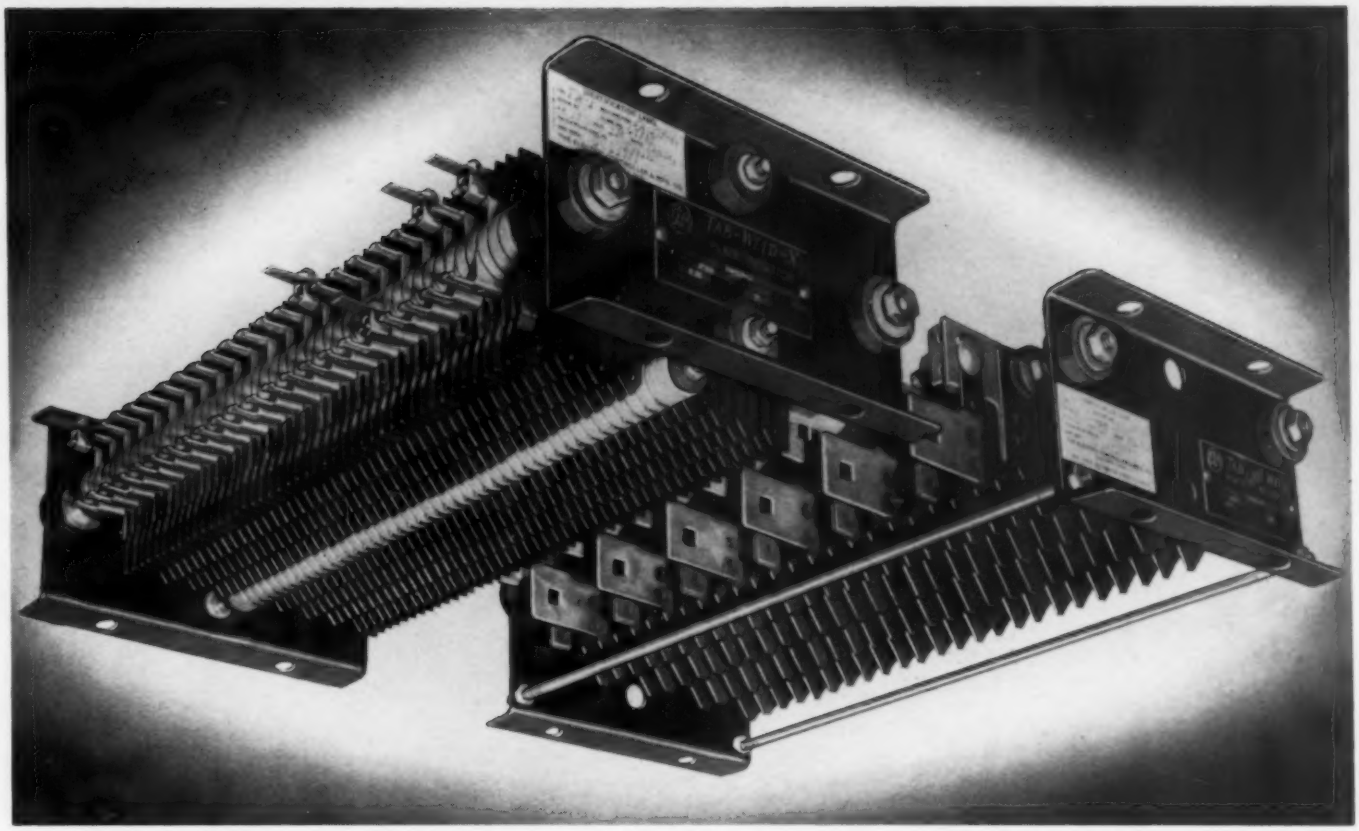
There is Only One Rust-Oleum

Distinctive as your fingerprint, Rust-Oleum is an *exclusive formula* developed by a Master Mariner during more than 20 years battling actual rust conditions at sea. It incorporates a *specially-processed* fish oil vehicle that will *dry*, is *odor-free*, and is formulated in *many colors*. Be sure you specify genuine Rust-Oleum to assure satisfaction. Accept no substitute.

ATTACH TO YOUR LETTERHEAD—MAIL TODAY!

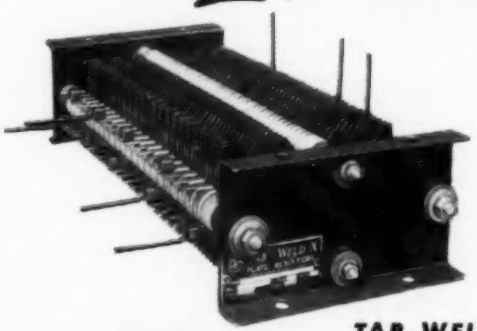
RUST-OLEUM CORPORATION
2445 Oakton St., Evanston, Illinois

- ☐ Have a Qualified Representative Call
- ☐ Free Survey
- ☐ Complete Literature
- ☐ Nearest Source of Supply

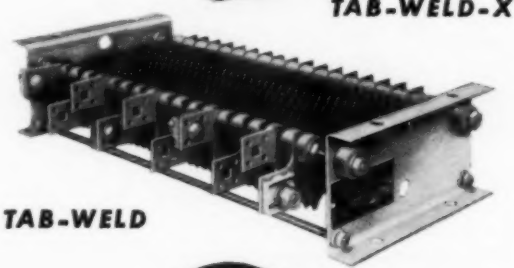


LOOK UP TO TAB-WELD PLATE Resistors

for less preventive-maintenance and lower upkeep-costs



TAB-WELD-X



TAB-WELD

From any angle, you can see the inherent features of EC&M TAB-WELD Plate Resistors. First bolted—then WELDED, these resistors are designed to help you cut corners on maintenance.

No burning at grid-eyes or at tap-plates. No periodic tightening of end-clamping nuts—welding insures a continuous current path — stabilizes the OHMIC value, independent of end-clamping pressure.

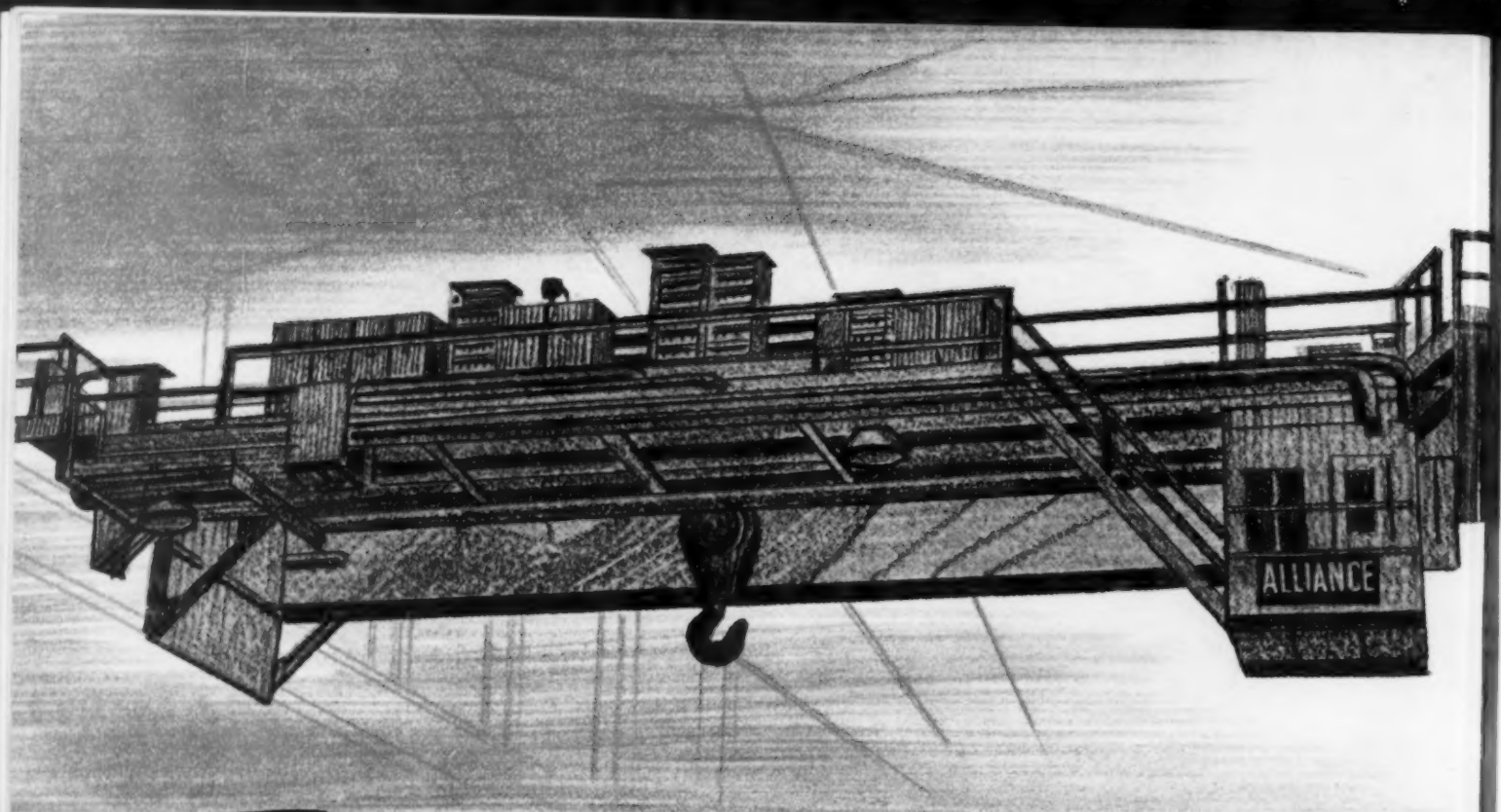
Along the sides, out of the path of the rising heat, are many convenient tap-plates which simplify tap-shifting—make on-the-job connections easy, and readily permit small adjustments in resistance-value. Sections may be used directly "off-the-store-room shelf"—no shop alterations are needed.

Remember too, these alloy-steel resistors are corrosion-resisting—and have negligible resistance-change between cold and maximum working temperatures.

Specify Bulletin 942 TAB-WELD Resistors

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET • CLEVELAND 4, OHIO



Alliance . . .

again chosen to construct special purpose crane

Charging electric furnaces capable of 70-ton heats is no problem for this new Alliance Crane. Designed to handle special charging buckets and equipped with a 10-ton auxiliary hoist, this new Alliance Crane has a 60-ton capacity; a 60-ft. span and a high lift of approximately 60 ft. Equipped with a magnet, this crane loads buckets with scrap and trips load into furnace with ease and accuracy. Alliance Machine Company offers this new crane as an excellent example of how Alliance engineers collaborate with steel company engineers the world over to help them improve their heavy material handling problems. Contact Alliance, world's largest builders of the world's largest cranes for information concerning equipment best suited to your company's operation.

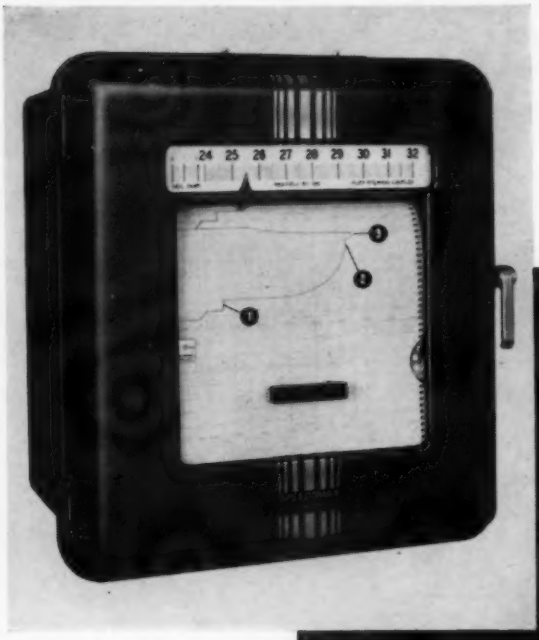
LADLE CRANES · GANTRY CRANES · FORGING MANIPULATORS · SOAKING PIT CRANES
STRIPPER CRANES · SLAB AND BILLET CHARGING MACHINES · OPEN HEARTH CHARGING
MACHINES · SPECIAL MILL MACHINERY · STRUCTURAL FABRICATION · COKE PUSHERS

World's Largest Builders of World's Largest Cranes

THE Alliance MACHINE COMPANY

MAIN OFFICE
ALLIANCE, OHIO

PITTSBURGH OFFICE
1622 OLIVER BUILDING, PITTSBURGH, PA.



Significant points on chart of Speedomax Immersion Thermocouple Recorder at left are: (1) standardization of recorder circuit during couple immersion; (2) temperature of steel bath, and (3) increase in thermocouple temperature during withdrawal through slag. Entire measuring sequence is swiftly recorded by Speedomax in less than one minute.

In the illustration below, an operator plunges an L&N Immersion Thermocouple, connected to a remotely-located Speedomax Recorder, into the steel bath . . . withdraws it as soon as the Recorder signals that temperature measurement is complete.

Important Speedomax Feature

guards accuracy

of Bath Temperature Measurements

• Now the L&N Immersion Thermocouple Recorder standardizes itself during each measurement . . . helps assure quick, accurate use of immersion thermocouples in measuring temperatures of molten steel.

Occurring only *seconds* before the thermocouple reaches maximum temperature, this adjustment eliminates variations resulting from ambient temperature changes. And since standardization is completely automatic—initiated by each immersion of the couple into the steel bath—the operator is freed of responsibility for this critical detail.

This simplicity characterizes all steps in using the Speedomax Recorder and Signal System for immersion measurements. Signal lights at the furnace, remotely operated by the Recorder, indicate whether the immersion equipment is operable, and warn when bath temperature is reached. Each immersion then results in a significant measurement—and minimum exposure to the high temperature prolongs couple life.

Used with the widely-accepted L&N Immersion Thermocouple, or with *any* immersion couple, the Speedomax Recorder and Signal System promotes improved immersion techniques and reliable measurements . . . results in reduced cost per reading.

For details, write us at 4942 Stenton Avenue, Philadelphia 44, Pa., for Folder N-33-640 (1), "Measure Bath Temperatures Effectively" or contact your nearest Leeds & Northrup representative.

CAREER OPPORTUNITIES AT L&N

Expansion program of this long-established firm has many features to attract outstanding recent graduates in engineering and science. Opportunities are in sales field engineering, product and application engineering, research, advertising, market development. Widely-respected policies assure recognition of progress and achievement. Address Personnel Manager for preliminary interview at nearest of 17 L&N offices.

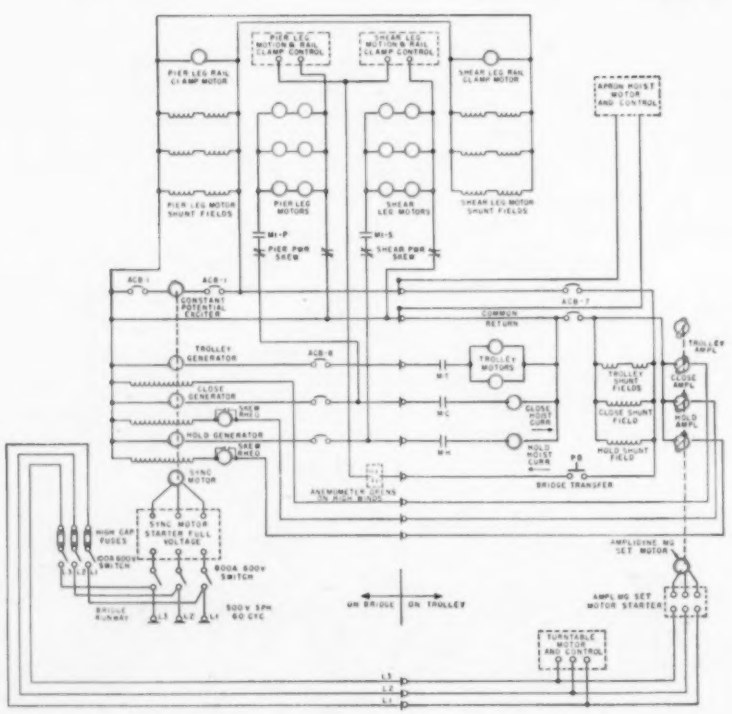
Jrl. Ad N-33-640 (3)

LEEDS NORTHRUP

INSTRUMENTS
AUTOMATIC CONTROLS
FURNACES

All electric equipment for this new ore bridge was supplied by Canadian General Electric. Heyl and Patterson, Inc. of Pittsburgh designed and built the bridge for Dominion Foundries and Steel, Limited, of Hamilton, Ontario.

New ore-bridge drive gives

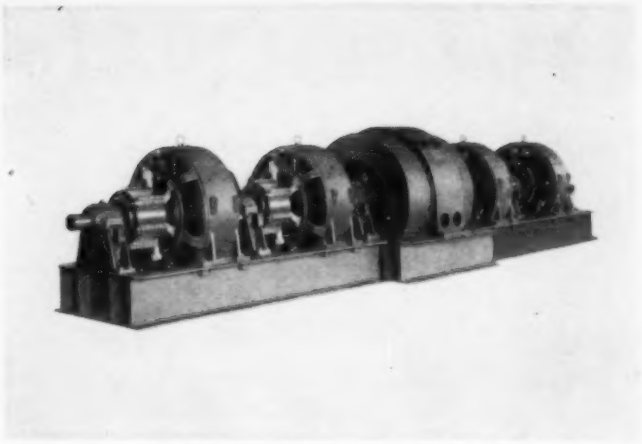


How this new drive works:

The synchronous-motor-driven generators on the bridge structure supply adjustable-voltage power to the hold, close, and trolley motors on the man-trolley; also constant-potential power for motor fields, brakes, control, and the apron hoist. Each adjustable-voltage generator is controlled by an amplidyne on the man-trolley. In addition to voltage- and current-limit control, the hold and close line amplidyne circuits include provision for automatically matching motor loads when hoisting or lowering a closed bucket or matching motor speeds when lowering an open bucket.

By means of a foot switch, the operator transfers the hold and close generators and control to the pier and shear leg drives; thereby obtaining smooth acceleration and deceleration of the bridge structure. Each leg may be controlled independently, but when operated simultaneously, automatic alignment is provided by means of skew rheostats.

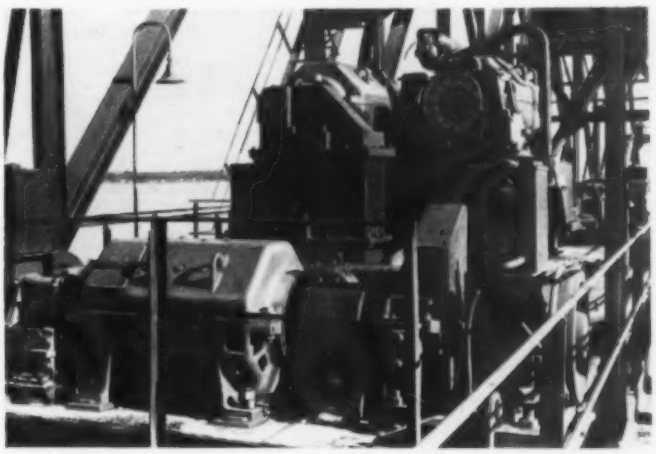
Another Example of G-E drive engineering at work!



Amplidyne-excited generators in the main 5-unit m-g set (similar to one above) power trolley, hold, close, and bridge travel motors

Apron hoist that permits raising apron for ore boat's entry is driven by a sturdy G-E 45-hp mill-type d-c motor.

Three of 12 G-E mill-type d-c motors and brakes that drive the shear and pier legs. Automatic skew control maintains alignment between legs.



Top deck of trolley contains four 150-hp continuous rated G-E mill motors for hold, close (on turntable) and trolley drives, each equipped with a G-E mill-type brake.

more precise bucket control

Amplidyne adjustable-voltage system also speeds trolley travel, cuts power losses and maintenance costs

Here is the first application of an amplidyne-controlled adjustable-voltage drive system to an ore bridge—engineered jointly by Canadian General Electric and Heyl and Patterson, Inc. of Pittsburgh. This drive system, already proved in other industries, now brings to ore bridge operation these major advantages:

More accurate bucket control, with less master switch handling and less operator fatigue, because load is divided and speed matched *automatically* between hold and close motors.

Faster trolley travel, with less shock to gears, because constant rate of acceleration and deceleration brings trolley up to full rated speed faster, stops it in less time.

Less power consumption because there are no banks of power resistors to cause power losses.

Smaller, lighter trolley design, because large banks of power resistors and heavy power contactors are eliminated, smaller frame motors and brakes are used.

Less maintenance, because resistors and power-interrupting contactors are done away with, smooth acceleration and deceleration minimizes stress on structural members.

What does this example mean to you? Simply this: G-E engineering successfully uses the *system* approach to solve any drive problem—including *yours.* For more information, contact your G-E steel-mill specialist or write for Bulletin GET-1789A. *General Electric Company, Section 659-89, Schenectady 5, N. Y.*

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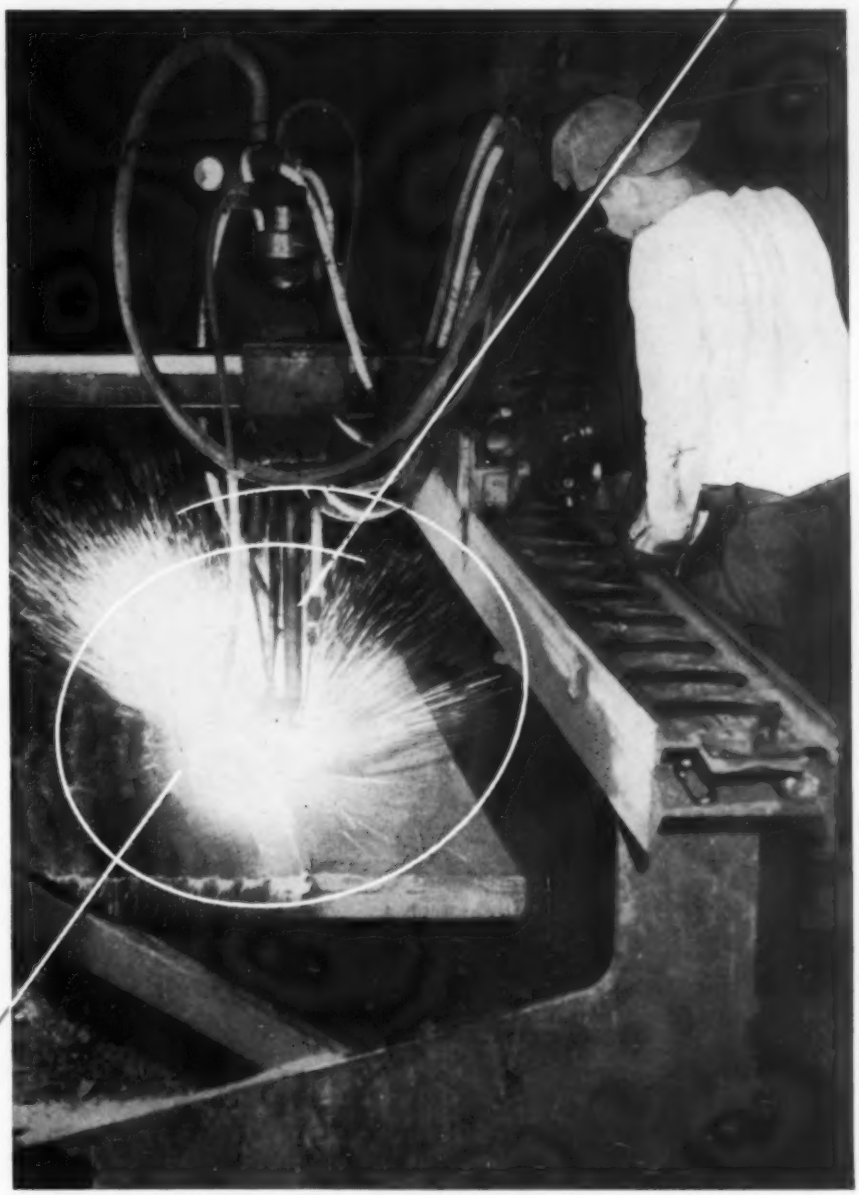

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* **LINDE SERVICE** is the unique combination of research, engineering, and over 40 years of accumulated know-how that is helping LINDE customers save money and improve production in their uses of oxygen and oxy-acetylene processes.

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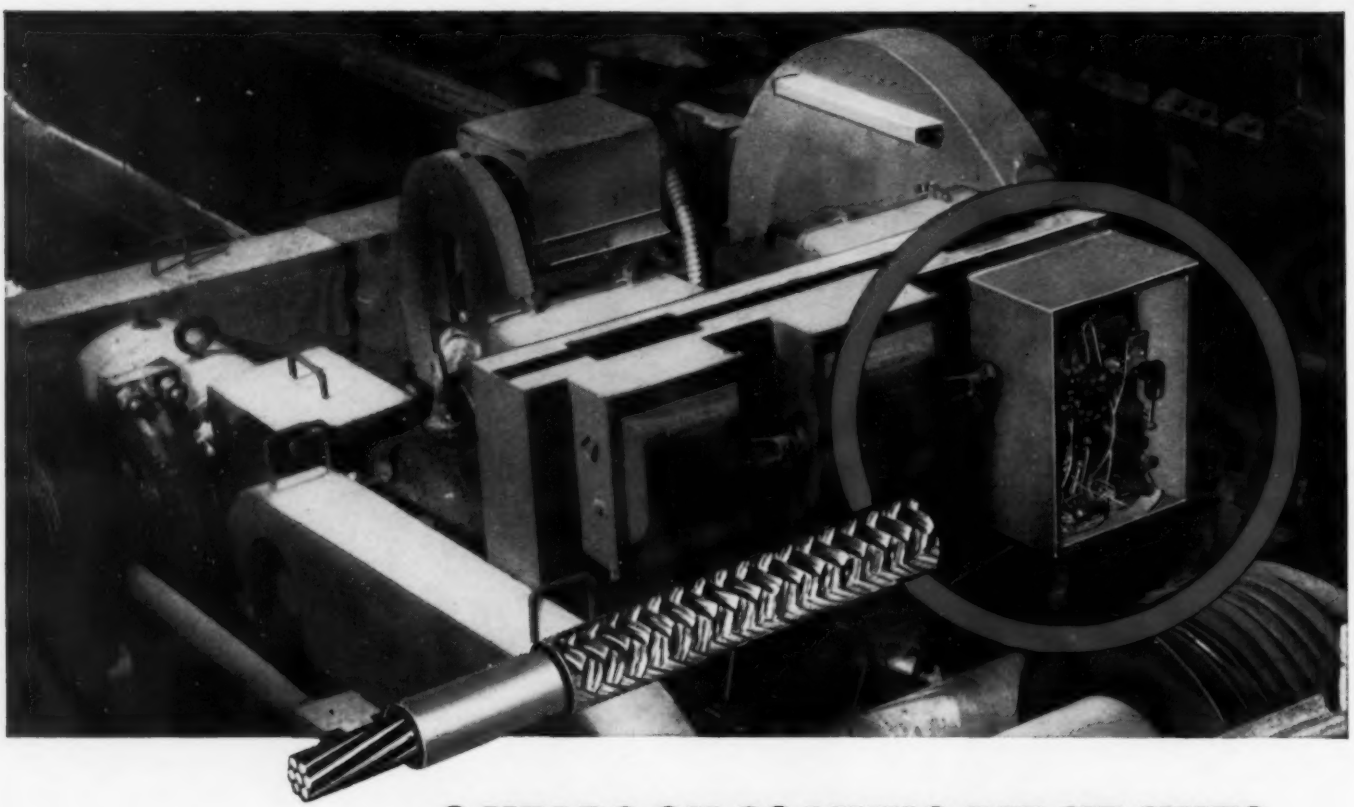

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The best cable is your best policy

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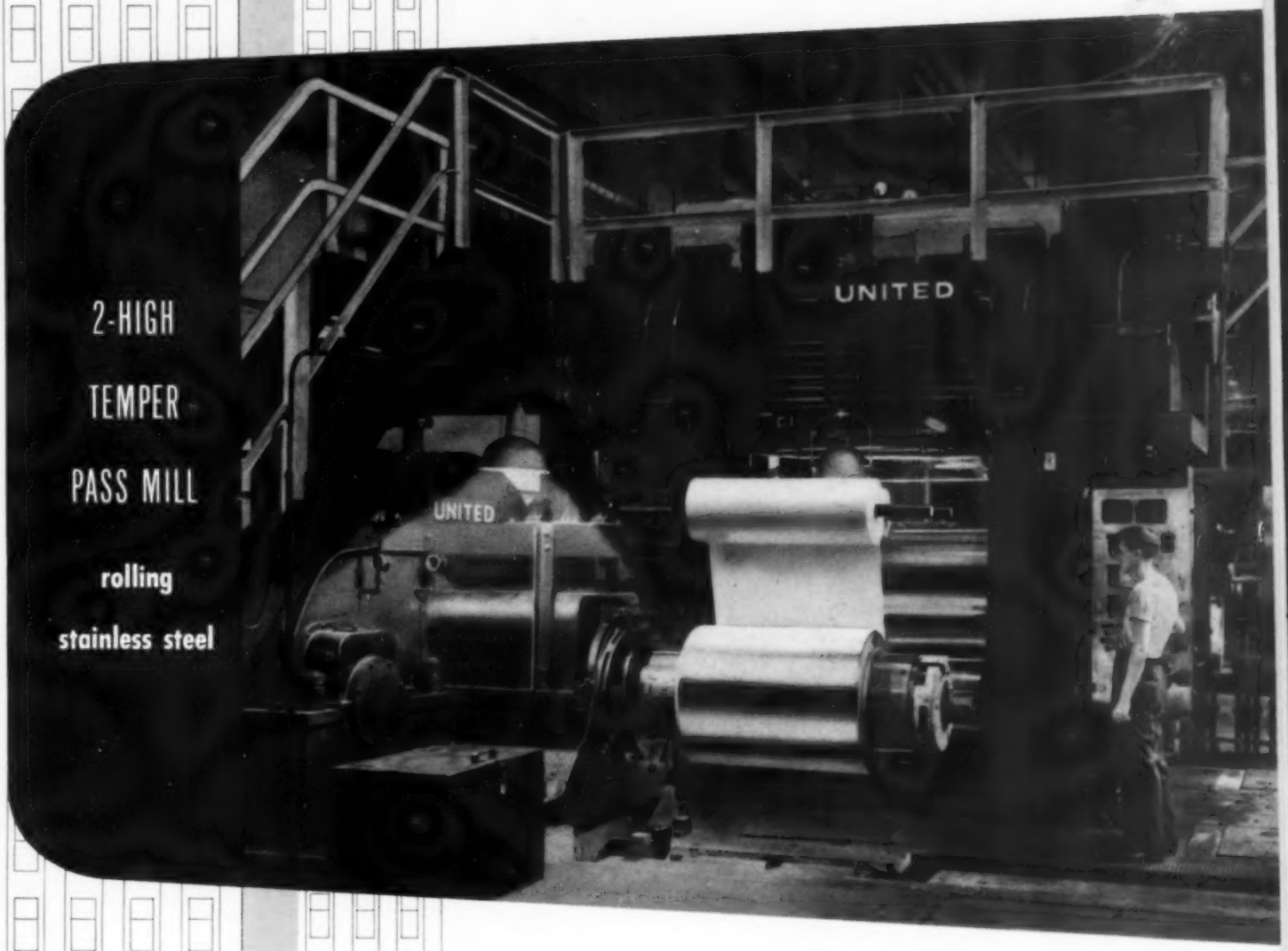

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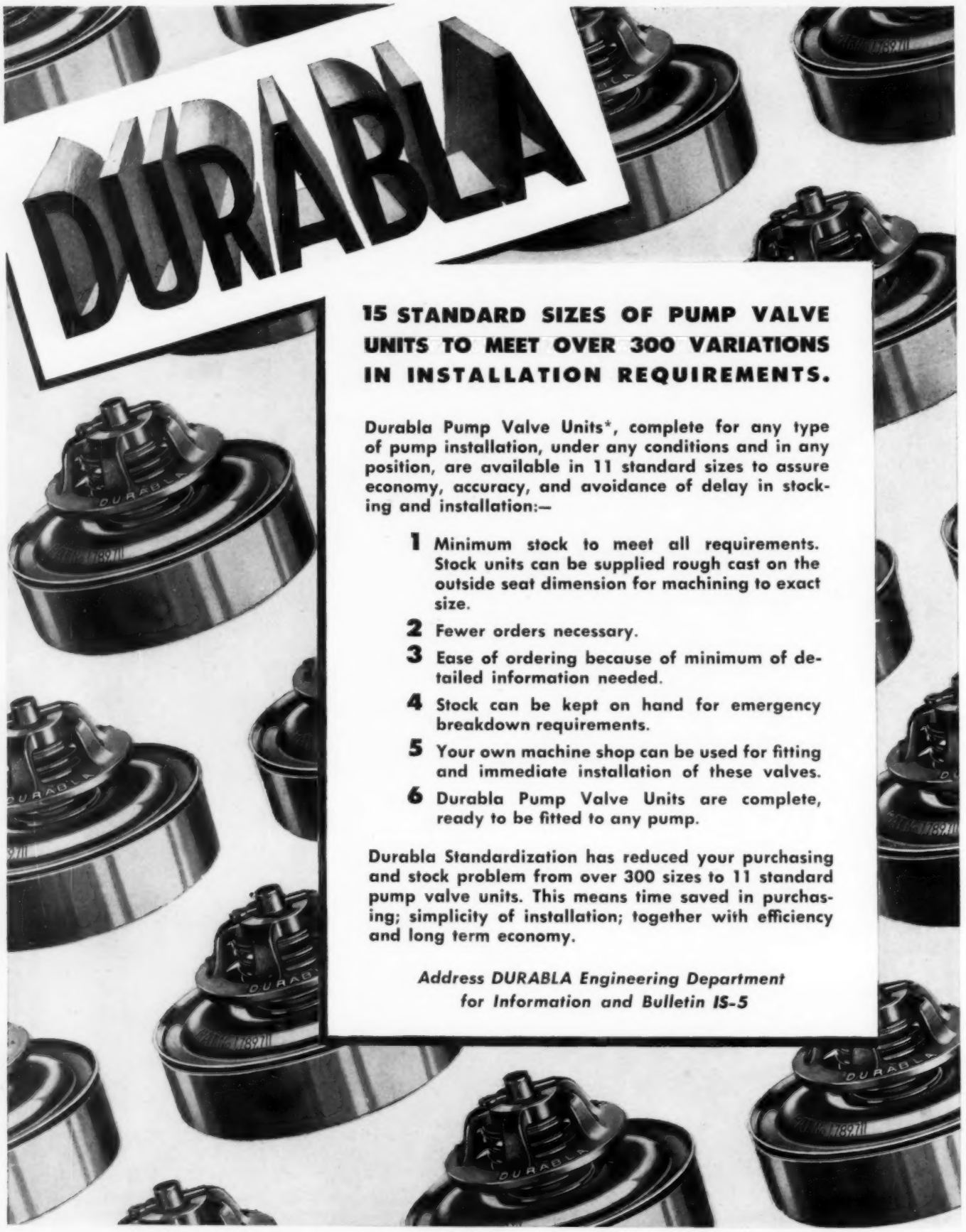

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The six motors are carried on the individual trucks, each motor being coupled to a worm reduction unit on the drive axle. With this type of drive, the usual squaring shafts are eliminated.

On account of the moving mass to be controlled, which would require the usual hydraulic brake for each drive, an air braking system is provided.

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Patent Reviews

By MELVIN NORD
Patent Attorney
Detroit, Mich.

. . . . copies of patents may be obtained from the Commissioner of Patents, Washington 25, D. C., at 25 cents each . . . . patents reviewed cover period January 20, 1953 through February 17, 1953 . . . .

INGOT MOLD WITH RAPID SOLIDIFICATION AT THE BOTTOM

▲ Molten steel in an ingot mold solidifies inwardly from the mold wall at an extremely rapid rate initially. The rate of solidification decreases sharply to a depth of about 1½ in.; beyond this depth it is relatively low and decreases slowly. Mathematically, solidification follows Feild's equation $d = k\gamma t$, where d is the solidification depth in inches, t is the time in minutes, and k is a constant. The value of k is normally between 0.75 and 1.00, increasing with increased mold wall thickness and with decrease in ingot width. The thicker the wall, the more heat extracted from the liquid and transferred to the cold wall, and therefore the more rapid the solidification rate. Solidification is also more rapid from the corners of an ingot of rectangular cross-section than from the sides, because the corners are subject to heat extraction by two adjacent mold walls.

It has long been recognized as

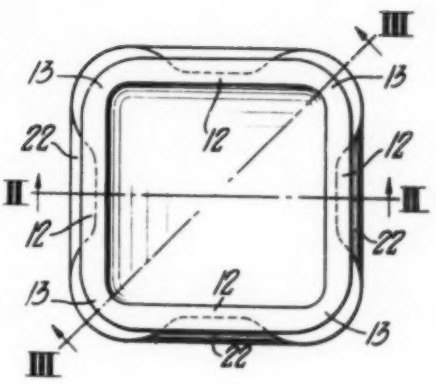
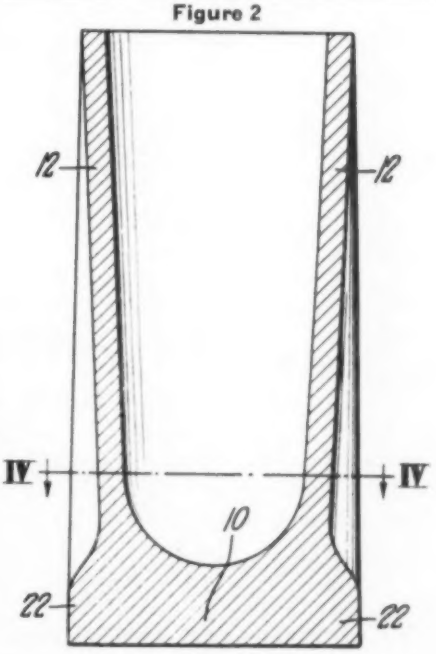


Figure 1

desirable that heat be extracted more rapidly from the bottom portion of a solidifying ingot than from the top portion. Preferably, the bottom portion should solidify completely while there is still a relatively wide column of liquid at the top. The face of vertical solidification in the middle of an ingot is roughly a V-shape. The angle of the V as it approaches the top of an ingot is a criterion of the soundness of the ingot. A wide angle indicates soundness, while a sharp V-angle indicates the likelihood of segregation, pipe, and porosity in the upper middle portion of the ingot.

In order to obtain favorable solidification conditions, mold walls taper upwardly and are commonly 2 or 3 in.

Figure 2



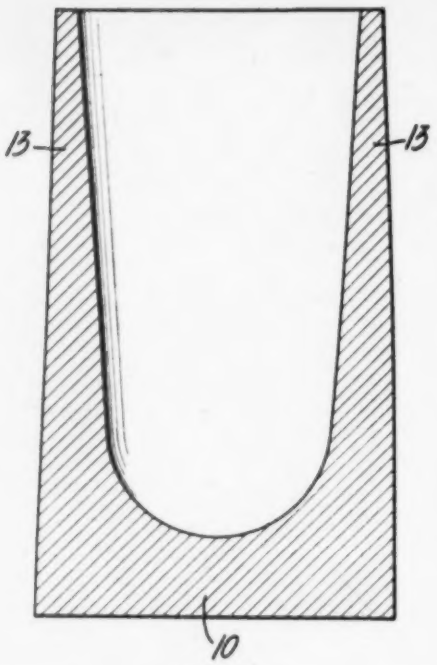


Figure 3

thicker at the base than at the top. However, it has been found experimentally that the expected difference in solidification rate (faster at the bottom than at the top) is largely lost, because of heat transfer through the ingot wall from the top to the bottom, under the temperature gradient which becomes established.

In U.S. 2,626,436, by Edgar Marburg, assigned to United States Steel Corp., a novel mold design is used to accomplish the desired rapid solidification rate at the bottom of the ingot. One form of the mold is shown in Figures 1, 2, 3, and 4. Figure 1 is a top plan view of the mold, Figures 2 and 3 are vertical sectional views along lines II - II and III - III of Figure 1, and Figure 4 is a horizontal sectional view taken along line IV - IV of Figure 1.

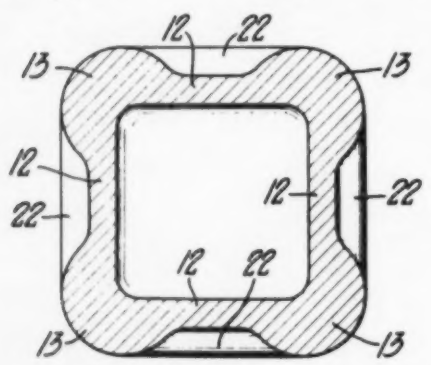


Figure 4

The mold is of square cross-section. The side walls 12 are of uniform thickness. The corner walls 13 taper upward, being much thicker at the base than the sides, and somewhat thinner at the top than the sides.

When molten metal is introduced into this mold, the side walls 12 are quickly heated. Near the base a temperature gradient develops between the hot side walls and the enlarged corner walls which are relatively cool. As a result of this gradient, the k-value for transverse solidification is much greater than it would be in a mold of uniform thickness. As the corner thickness decreases upwardly, the k-value for solidification also decreases. Near the top, the corners are thinner than the sides, so that they are not effective as chills. Thus the k-value for solidification across the top of the ingot is less than that for an ingot cast in a mold of uniform wall thickness, and is considerably less than the k-value for solidification across the base of the same ingot.

BOTTOM PORTS FOR SOAKING PITS

Soaking pits usually consist of a large box-like enclosure which is fired at the bottom or the side. In bottom-firing, the pit is heated by means of a burner port located in a central portion of the hearth, through which the flame is introduced. Ingots to be heated are charged on the hearth surrounding the burner port and are there soaked or heated through, preparatory to their being rolled into plates or other shapes. In side-firing, the flame is introduced into the pit by several burner ports located in the side walls of the pit, and the exhaust gases are permitted to escape through an exhaust port in a central part of the hearth.

A very important feature of this central port — whether it be an exhaust port for a side-fired furnace or a burner port for a bottom-fired furnace — is the fact that it projects upwardly somewhat above the level of the hearth and is therefore subjected to the intense heat of the furnace which causes spalling and other failures of the brick from which the port is built. In addition, as the large billets or ingots are charged and removed they tend to swing about considerably and often strike the port, subjecting it to considerable physical abuse. The port is also subject to early deterioration due to its many joints. These make the structure less compact, more subject to the spread of slag through to the flues below and less resistant to spalling, and when this structure becomes loose it is easily broken by a slight bump from an ingot. Replacement of the port is costly because it requires cooling or shutting down the furnace, followed by the gradual application of heat to the wet bricks and mortar which have been used in the repairs. One method of overcoming these disadvantages which has been tried is making a complete port of a heavy cast steel or cast iron spider over which a plastic chrome material was rammed into place. The principal difficulty with this is that the metal expands due to heat and to scaling because of oxidation, while the refractory shrinks while drying. This causes cracks to open up in the ring or rosette, thereby hastening its destruction.

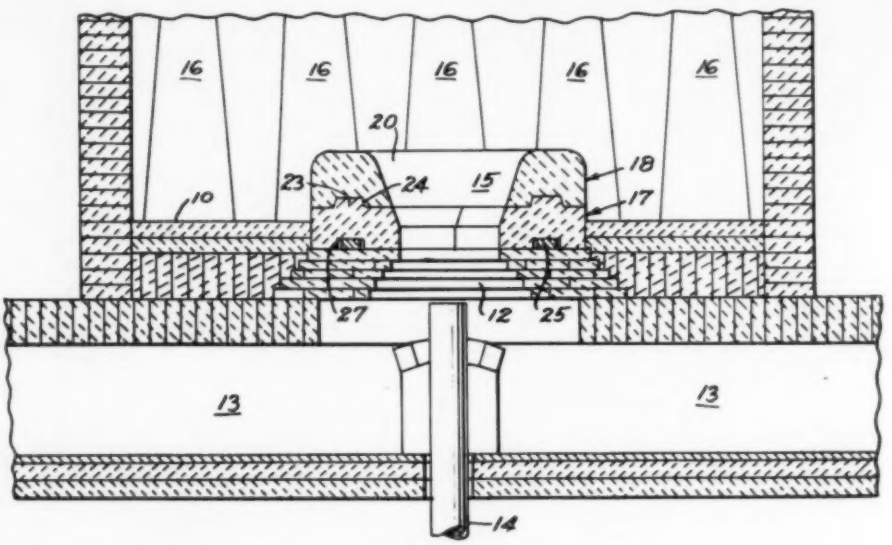
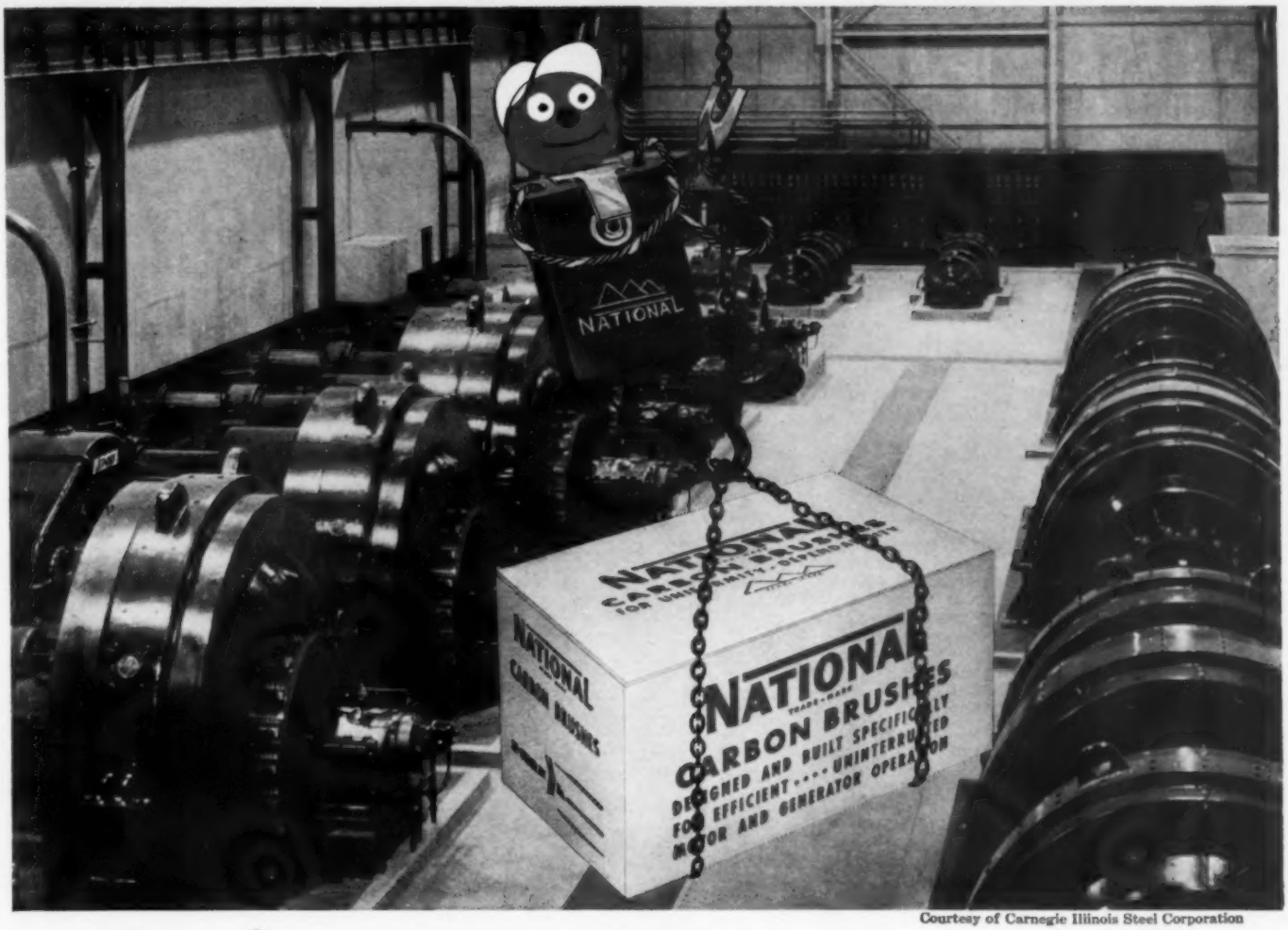


Figure 5



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In U.S. 2,628,088, by Leslie W. Austin and John D. Isaacs, assigned to Kaiser Steel Corp. and Kaiser Aluminum and Chemical Corp., an improved form of prefabricated rosette is described. In Figure 5, a burner port of the new type is shown assembled in the hearth of a soaking pit. Figure 6 is a perspective view of the partially dismantled rosette, and Figure 7 is a sectional view of the rosette, with a yoke attached for transporting it to position in the soaking pit. In Figure 5, the port 12 is located in the center of the hearth 10 and connects with flues 13 which provide preheated air to burn the gas

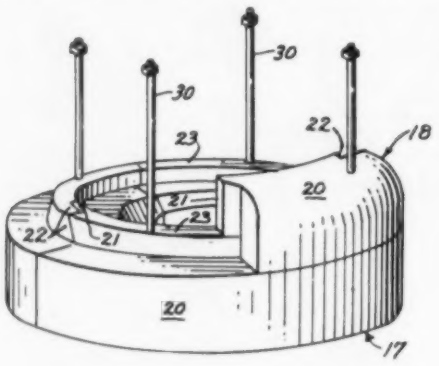

Figure 6

admitted through pipe 14. The rosette or ring 15 projects upwardly into the soaking pit. Ingots 16 are located about the port. The rosette combines with the burner opening to produce the desired shape in the port opening for inducing the proper flow of gas and air into the furnace for efficient combustion.

The rosette consists primarily of two refractory rings 17 and 18, one of which is superposed upon the other. Each of these rings may consist of several interfitting segments 20 having tongue and groove ends 21 and 22, which securely join together to form a single compact ring. The segments of the bottom ring also contain an upstanding tongue 23 which fits into a groove 24 on the under side of the sections making up the upper ring. Thus, the entire rosette is locked together to form a single compact

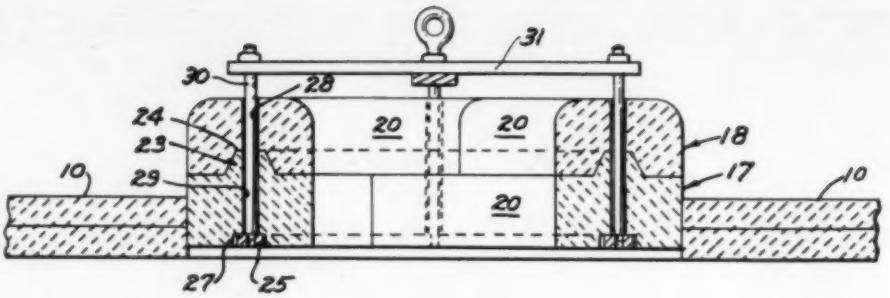

Figure 7

mass. A metal ring 25 is placed in a groove in the bottom of the lower ring, and vertical openings 28 and 29 permit the insertion of threaded tie rods 30 to be screwed into the metal ring 25. A yoke unit 31 may then be fastened at the top of the tie rods for hoisting the entire ring into the soaking pit. After the rosette has been placed in position in the port opening, the tie rods are unscrewed and lifted out by the yoke. Since the remaining metal ring 25 is relatively small, and since it is mounted in such a way that there is room for expansion, it creates little or no pressure on the refractory ring.

Other modifications are also described in the patent specification.

DESCALING OF STEEL SHEET OR STRIP

Continuous products such as rolled steel sheet or strip, wire, or rods are descaled in a molten salt bath in U.S. 2,628,627, by Ernest Huff.

When molten sodium hydride is used to descale strip, the scale forms a sediment or sludge on the bottom of the bath. The present invention provides a means for removing the deposit more easily than the usual way of removing the bath cover and shoveling it out manually. The improvement consists essentially in providing a tray near the bottom of the bath for collecting the sludge, and interconnecting the tray with the bath cover in such a way that the cover and tray are movable together by a hoisting mechanism to a position above the bath. In this way, workmen have free access to remove the sediment from the tray. The method is said to save time and labor, to reduce the hazards of the operation, and to avoid the exposure of the molten bath to the cooling and oxidizing influence of the atmosphere.

OTHER PATENTS OF INTEREST TO THE IRON AND STEEL ENGINEER

Patent No.	Subject of patent	Inventor or assignee
2,625,944	Quenching apparatus	Selas Corp. of America
2,625,945	Quenching apparatus	General Electric Co.
2,626,863	Desulphurization of metals and alloys by silicon	Union Carbide & Carbon Corp.
2,626,895	Electrolytic production of iron	Fansteel Metallurgical Corp.
2,627,704	Apparatus for grinding blooms and slabs	Republic Steel Corp.
2,627,969	Conveying apparatus for steel sheets	Republic Steel Corp.
2,627,976	Magnetic separator	Roswell H. Stearns and Roswell N. Stearns
2,628,495	Hardness tester	Kenneth M. Day
2,628,726	Sheet metal feeder	Robert Van Schie
2,628,790	Reeling furnace for hot band rolling	Westfalenhutte Dortmund Aktiengesellschaft
2,628,924	Method of cleaning electroplated metal strip	National Steel Corp.

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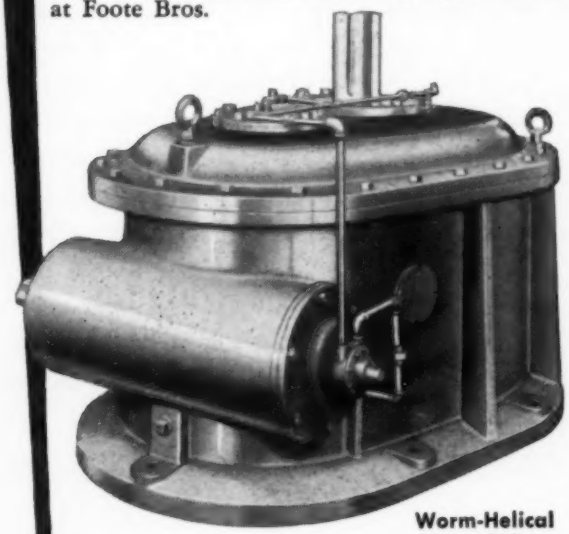
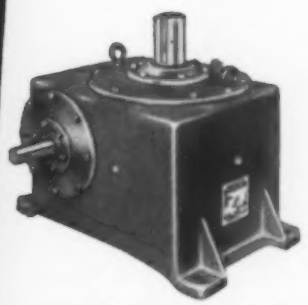


Worm-Helical Gear Drive

Foote Bros.-Louis Allis Gearmotor Extended Shaft



Hygrade Worm Gear Drive Standard Shaft

Hygrade Worm Gear Drive Extended Shaft

Line-O-Power Drive Standard Shaft

Line-O-Power Drive Extended Shaft

FOOTE BROS.

Better Power Transmission Through Better Gears

FOOTE BROS. GEAR AND MACHINE CORPORATION
4545 South Western Boulevard • Chicago 9, Illinois

Foote Bros. Gear and Machine Corporation
Dept. IAS, 4545 South Western Boulevard
Chicago 9, Illinois

Please send me information on the following vertical drives:

- ☐ Line-O-Power Drives
- ☐ Foote Bros.-Louis Allis Gearmotors
- ☐ Hygrade Drives
- ☐ Worm-Helical Gear Drives

Name.....

Company.....

Address.....

Position.....

City.....Zone.....State.....

Tough Insulator Problem?

HERE'S YOUR ANSWER!

NEW KEYSTONE GLASTIC INSULATORS

WITHSTANDS IMPACT AND SHOCK—Has superior physical and dielectric properties.

RESISTS HIGH HEAT—Withstands operation under maximum sustained temperatures up to 300°F

NON-ABSORBENT—Resists chemicals, most acids, salts and hydrocarbons.

Put new Keystone GLASTIC Insulators to work on your tough insulator problems! Where installation requirements demand extra strength and longer life, Keystone GLASTIC Insulators offer greater cantilever strength, increased puncture strength, and exceptional resistance to arc tracking.

Glass fiber construction imparts ability to resist impact, thermal shock and vibration. GLASTIC Insulators are unaffected by moisture, high heat, chemicals and rough handling. You get advantages not obtained with insulators of phenolic composition. GLASTIC Insulators can be designed to your individual requirements.

The new GLASTIC Insulator is one of a complete Keystone line available for use with rail, wire or angle conductors in either over-running or under-running operation.

SEND FOR BULLETIN

ELECTRIC SERVICE MANUFACTURING CO.

PHILADELPHIA 32, PENNA.

REPRESENTED IN CANADA BY LYMAN TUBE AND BEARING, LIMITED, MONTREAL AND TORONTO

MANUFACTURERS OF COMPLETE LINE OF INSULATOR SUPPORTS FOR RAIL AND WIRE CONDUCTORS AND CURRENT COLLECTION DEVICES.

This Link-Belt belt conveyor (with part of cover removed) easily handles coke breeze for blast furnaces at steel mill.

TOTAL ENGINEERING

It's LINK-BELT's answer for improved belt conveyor performance

BELT conveyor efficiency begins with correct analysis of overall system requirements. And right from the start Link-Belt offers you unique advantages. Our engineers can apply broad experience to your bulk handling problems.

Working with a complete line of quality components, they can select the belt conveyor equipment best suited to your exact needs. What's more, Link-Belt has a nation-wide engineering organization that will follow through on every detail. This includes supplying all related equipment . . . building supporting structures and enclosures . . . erecting the complete job, if desired.

It's easy to see why "total engineering" results in top belt conveyor performance. For complete information, call the Link-Belt office near you today.

13.131-E

LINK-BELT

BELT CONVEYOR EQUIPMENT

LINK-BELT COMPANY: Plants: Chicago, Indianapolis, Philadelphia, Colmar, Pa., Atlanta, Houston, Minneapolis, San Francisco, Los Angeles, Seattle, Toronto, Springs (South Africa), Sydney (Australia). Sales Offices in Principal Cities.

LINK-BELT builds a complete line of belt conveyor components

ALL TYPES OF ROLLER BEARING IDLERS

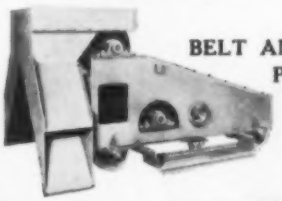
Impact-cushioning idler

45° troughed idler

Belt-training idler

20° troughed idler

Return idler



BELT AND MOTOR PROPELLED TRIPPERS

COMPLETE TERMINAL MACHINERY

Modern Safeguards—Brink's for Money, Bailey for Process Materials

Are Your Process Materials Guarded As Well?

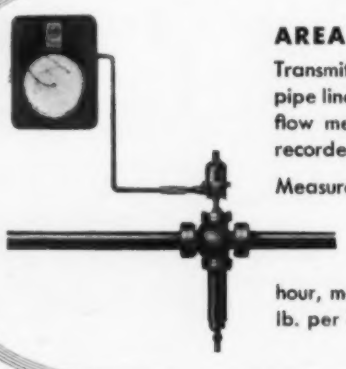
HERE'S HOW TO PREVENT SPOILAGE AND WASTE . . .

TO avoid waste of valuable process materials and finished products, process rates and conditions must be accurately measured and controlled. That's where Bailey Meters, Analyzers and Controllers can help you to improve the efficiency of your plant.

Take flow for instance. Bailey Meter Company offers a complete line of flow measuring and controlling equipment for applications ranging all the way from high pressure steam to low pressure gas. We measure flow in pipes, open channels, ducts, furnaces, smelters, kilns, ovens, dryers.

When you call Bailey Meter Company, you get the help of years of experience as well as recommendations from a wide selection of measuring and controlling devices.

Your local Bailey Engineer is as near as your telephone. He has the experience and the equipment necessary to set up an effective guard for your process materials. P-26



AREA TYPE FLOW METER

Transmitter goes into 1, 2 or 4 inch pipe line like a valve and transmits flow measurements electrically to recorder in remote location.

Measures oil and other clear liquids under static pressures up to 600 psi. Minimum range 0 to 1200 lb. per hour, maximum range 0 to 9600 lb. per hour.

BAILEY METER COMPANY

1047 IVANHOE ROAD
CLEVELAND 10, OHIO

Process Controls
TEMPERATURE · FLOW
PRESSURE · LEVEL
GAS ANALYSIS · RATIO

High precision slitter cuts .001" gage steel . . . *with help of TIMKEN® bearings*

TO INSURE the high precision needed to accurately cut .001" gage silicon steel, the Herr Engineering Company mounts the arbors of its multiple rotary slitter on Timken® tapered roller precision bearings. R. W. Herr reports: ". . . our main selling point on this piece of equipment is the high precision Timken bearings on the arbors which permit it to handle extremely thin material."

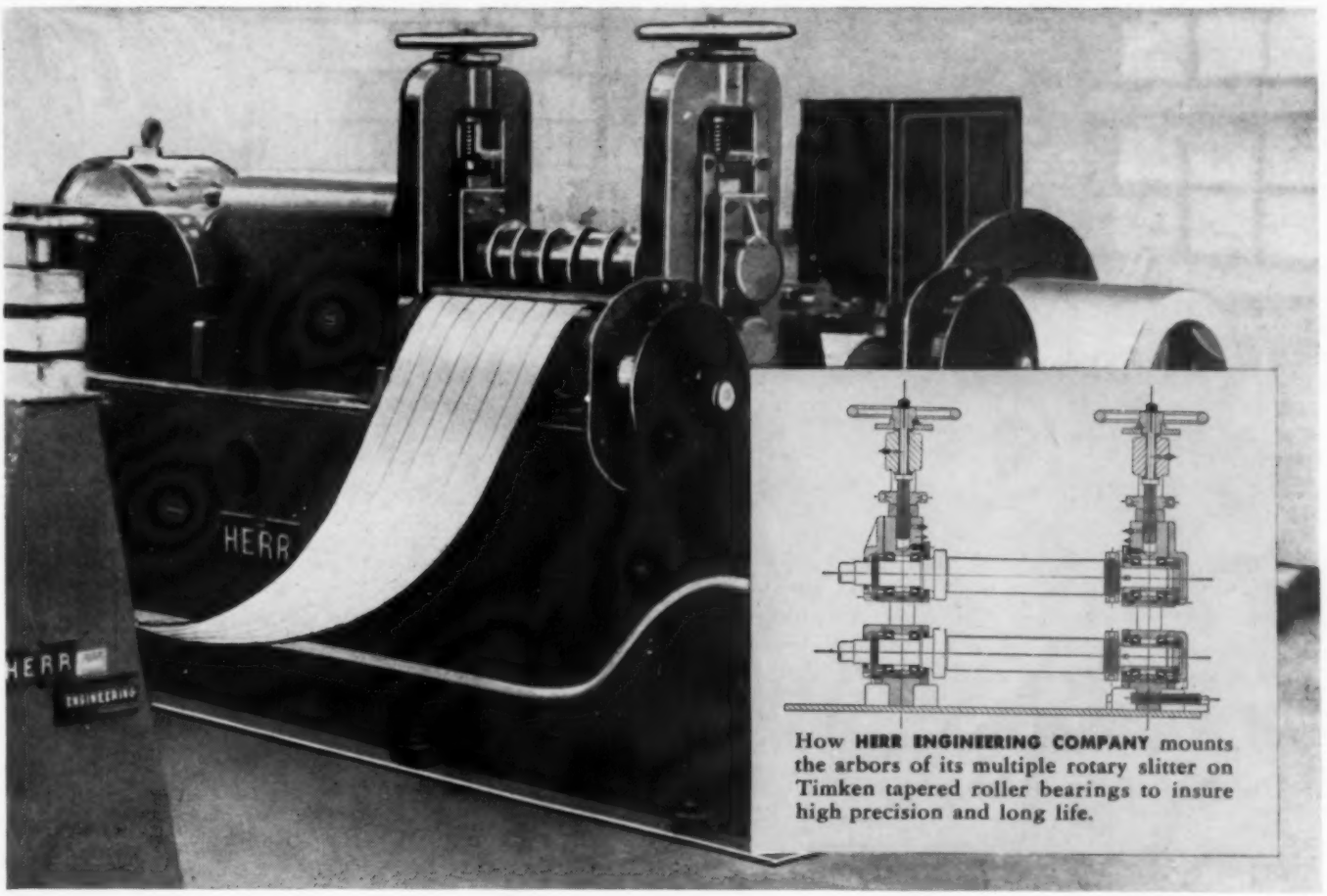
Because of their tapered construction, Timken bearings take radial and thrust loads in *any* combination. Line contact between rollers and races gives them extra load-carrying capacity. And with precision Timken bearings, the arbors have a minimum run-out, assuring precision slitting.

The true rolling motion and incredibly smooth finish of Timken bearings reduce friction to a minimum. They hold shafts and housings concentric, making closures more effective. Lubricant stays in—dirt and moisture stay out.

Timken bearings normally last the life of the machine. They're precision manufactured, engineered for the job and made of special analysis Timken fine alloy steel.

No other bearing can give you all the advantages you get with Timken tapered roller bearings. Specify them in the machines you build or buy. Look for the trade-mark "Timken" stamped on every bearing. The Timken Roller Bearing Company, Canton 6, Ohio. Canadian plant: St. Thomas, Ontario. Cable address: "TIMROSCO."

This symbol on a product means its bearings are the best.



How **HERR ENGINEERING COMPANY** mounts the arbors of its multiple rotary slitter on Timken tapered roller bearings to insure high precision and long life.

MAGNIFYING GLASS INSPECTION OF EVERY ROLLER!

Every one of the over one billion Timken bearing rollers produced every year is inspected with powerful magnifying glasses to detect surface flaws. It's just one example of how the Timken Company insures uniform high quality.

TIMKEN

TRADE-MARK REG. U. S. PAT. OFF.

TAPERED ROLLER BEARINGS

NOT JUST A BALL ◯ NOT JUST A ROLLER ⬭ THE TIMKEN TAPERED ROLLER ⬭ BEARING TAKES RADIAL ⓞ AND THRUST →ⓞ← LOADS OR ANY COMBINATION

STEEL MILL CRANES . . .

by "Shaw-Box"

Cranes for the Steel Mill have always been an important part of "Shaw-Box" production. Today, "Shaw-Box" has standard designs for cranes ranging from 15 to 100 tons to A.I.S.E. standard No. 6 specifications. So, when you buy "Shaw-Box", you get more crane for your crane dollar.

In "Shaw-Box" cranes, you get cranes built exactly to your specifications plus the advantages of "Shaw-Box" engineering, manufacturing techniques, performance, and maintenance conveniences that have built an enviable reputation for all "Shaw-Box" equipment.

SEND ALL YOUR INQUIRIES FOR CRANES AND SOAKING PIT CARRIAGES TO "SHAW-BOX".

"Shaw-Box" CRANES

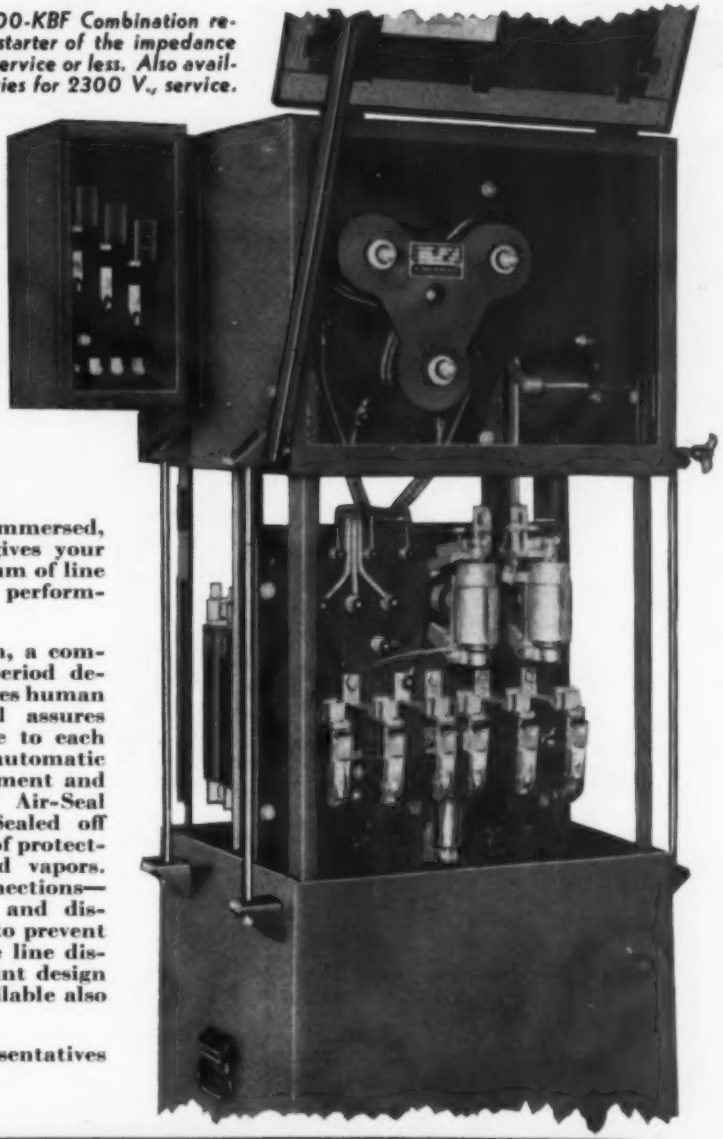
MANNING, MAXWELL & MOORE, INC.

Muskegon, Michigan

Builders of "Shaw-Box" Cranes, 'Budgit' and 'Load-Lifter' Hoists and other lifting specialties. Makers of 'Ashcroft' Gauges, 'Hancock' Valves, 'Consolidated' Safety and Relief Valves, and 'American' Industrial Instruments.

Oil Immersed

Rowan Type 900-KBF Combination reduced voltage starter of the impedance type, 600 V., service or less. Also available in 950 series for 2300 V., service.



ROWAN
Type 900 Series
REDUCED VOLTAGE STARTER

Push button operated—fully automatic—this oil immersed, reduced voltage starter of the impedance type gives your induction motors a smo-o-oth start with a minimum of line disturbance. Check its design, construction, and performance features:

√ Closed transition type—utilizes for acceleration, a combination of current and time. √ Acceleration period dependent upon driven equipment and load—eliminates human element. √ Continuous wound impedance coil assures freedom from tap failures—impedance adjustable to each application. √ Magnetic overload relays with automatic reset—provides a combination of inverse time element and instantaneous operation. √ Rowan time-tested Air-Seal fuses—dependable short circuit protection. √ Sealed off centralized wiring compartment—eliminates need of protecting incoming and outgoing leads from oil and vapors. √ Provision for straight through conduit connections—facilitates installation and inspection. √ Tank and disconnect mechanism is mechanically interlocked—to prevent the lowering of the tank before disconnecting the line disconnect switch. √ Enclosure is of weather-resistant design to meet the requirements of NEMA Type X1—available also for Class I Group D locations.

Complete information available from Rowan representatives in principal cities of the United States.

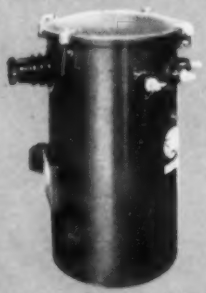
ROWAN CONTROL

THE ROWAN CONTROLLER CO., BALTIMORE, MD.

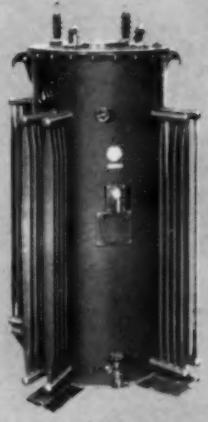
POLE STAR DISTRIBUTION TRANSFORMERS

Pole Star Distribution Transformers — 3 Kva through 500 Kva, 2400 through 67,000 volts

Protected Pole Star (CSP® Transformers) 3 Kva through 100 Kva 2400 through 14,400 volts



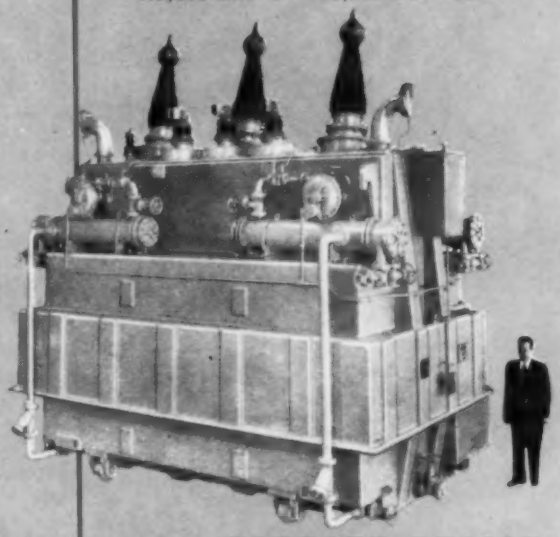
5 Kva Pole Star 2400/4160Y — 120/240 volts



500 Kva Pole Star 13,200 — 2400/4160Y volts

105,000 Kva, Three-phase

115,000 Grd. Y — 13,200 Delta volts

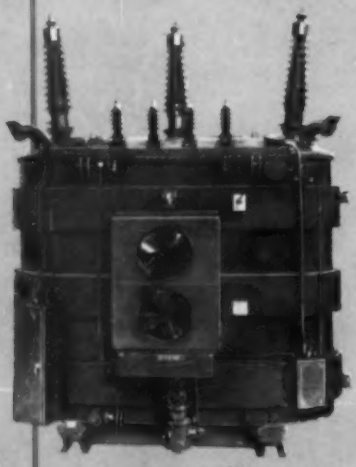


CONTOUR DESIGN

TRANSFORMERS...

PENNSYLVANIA TRANSFORMER COMPANY'S ONLY PRODUCT

CORE FORM POWER TRANSFORMERS



138,000 Volts

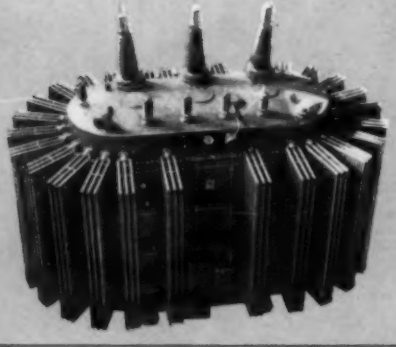
37,500 Kva, Three-phase 132,000 Grd. Y — 24,000Y/13,860 — 6900 Delta volts

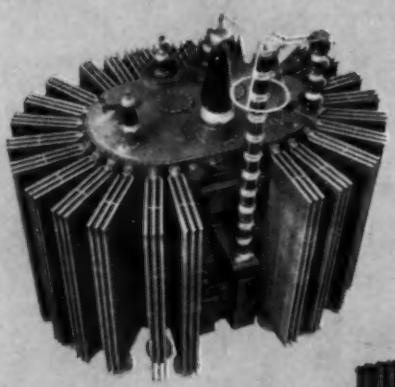
132,000 Volts

20,000 Kva, Three-phase, 132,000 Delta — 26,400Y/15,240 volts

161,000 Volts

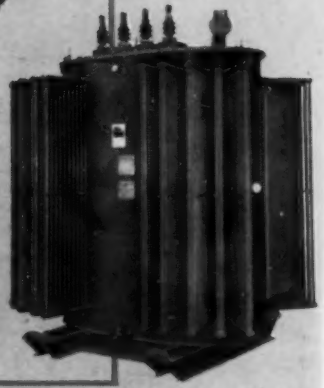
56,000/70,000 Kva. Single-phase. 93,000/161,000 Grd. Y — 19,000 volts

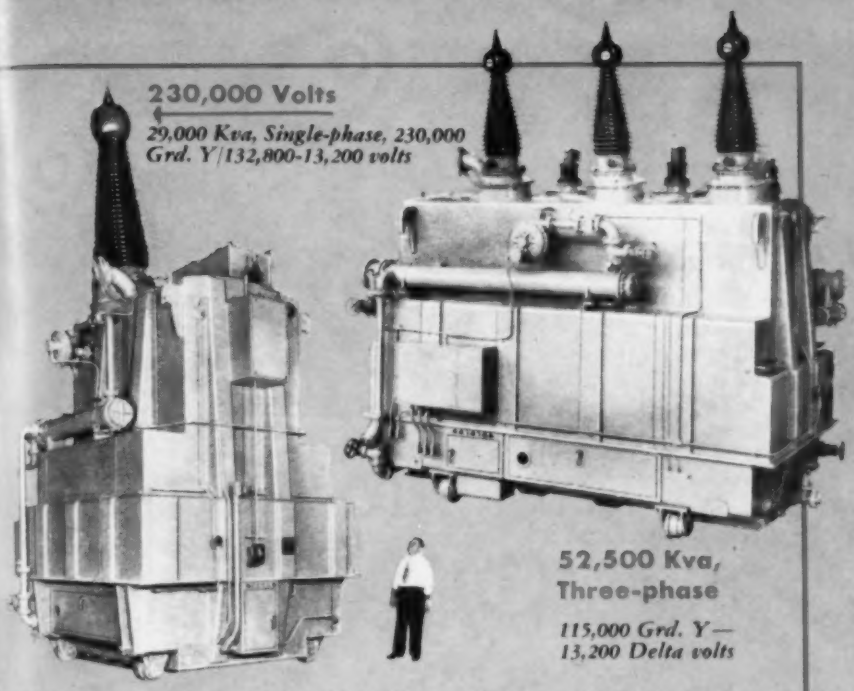




STANDARD PARTS POWER TRANSFORMERS

Three-phase: Up to 10,000 Kva, 34 Kv
Single-phase: Up to 5,000 Kva, 34 Kv





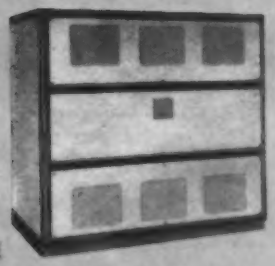
230,000 Volts

29,000 Kva, Single-phase, 230,000 Grd. Y/132,800-13,200 volts

52,500 Kva, Three-phase

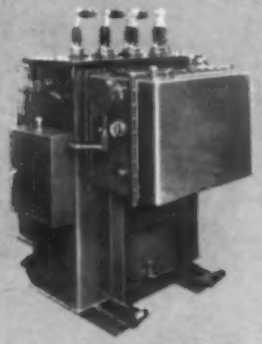
115,000 Grd. Y— 13,200 Delta volts

SHELL FORM POWER TRANSFORMERS



DRY TYPE

Sealed, Ventilated and Forced-Air-Cooled



STEP VOLTAGE REGULATORS

Up to 750 Kva for plus or minus 10% regulation in 32 steps

DISTRIBUTION TRANSFORMERS

3 Kva through 500 Kva
Up to 67,000 volts

POWER TRANSFORMERS

750 Kva to 250,000 Kva
Up to 330,000 volts

For 24 years, we have concentrated on designing and manufacturing one product — transformers. Each year we do more business than the previous year, and each year we keep bettering our product. We count among our customers the finest Utilities and Industrials in the country. We believe that if you are interested in transformers, you'll want to investigate Pennsylvania. We invite you to contact us.

PENNSYLVANIA TRANSFORMER COMPANY

A McGraw Electric Company Division

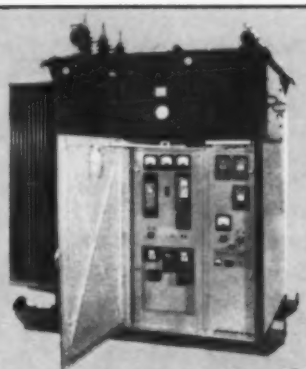
CANONSBURG, PA. *Greater Pittsburgh District*

ASKAREL

Non-inflammable, liquid-filled Distribution and Power Sizes

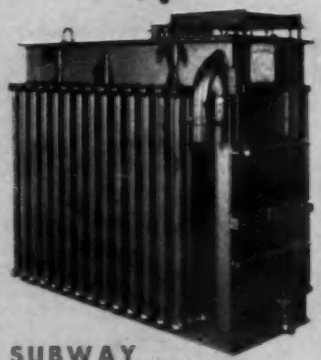
NETWORK

300 through 1,000 Kva. 2400 through 34,400 volts



UNIT SUBSTATION

Single-Circuit and Duplex Unit Substations



SUBWAY

Submersible Type, Single and Three-phase

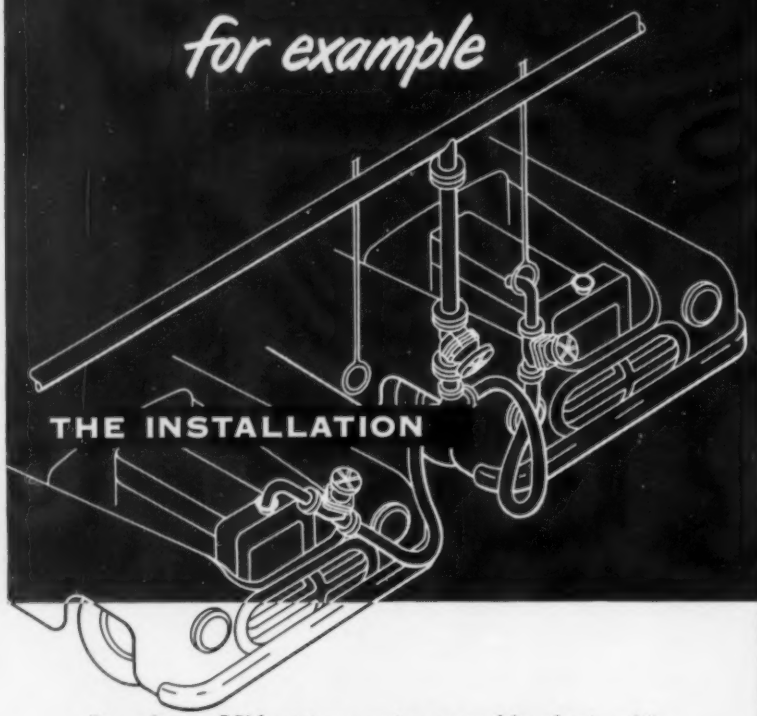
LOAD RATIO CONTROL

For changing transformer taps under load in sizes up to 50,000 Kva

FURNACE

For operating Electric Arc Furnaces of any tonnage

How Valve Life Changed from Days to Months ...on Crystalline Liquids, for example



In a large Midwestern auto assembly plant, with Crane Diaphragm valves in alcohol solution anti-freeze fill lines to automobile radiators.

VALVE SERVICE RATINGS

SUITABILITY: Doing the job O.K.

FEATURES: Packless; no leakage around stem

MAINTENANCE COST: None

SERVICE LIFE: Now 25 times longer than any valve used

OPERATING RESULTS: Damage to production stopped

PRICE: O.K. no premium

AVAILABILITY: Regular Crane Catalog item No. 1610

THE CASE HISTORY

None of the many conventional valves nor the plug cocks tried in this service lasted more than a week—about 2,000 operations.

The crystals present in anti-freeze would build up on seating surfaces and in the exposed valve stem threads. The valves leaked and were hard to operate. To the excessive maintenance needed was added the high cost of frequent damage to automobile finish by anti-freeze leakage.

Now Crane Packless Diaphragm valves control the trouble. Their sealed bonnet prevents contact of fluid and working parts; their seating design isn't hindered by crystal deposits. At last report, Crane valves have given over 50,000 trouble-free operations with no maintenance, and with indefinitely longer life assured.

THE VALVE

In Crane Diaphragm valves, the diaphragm serves only to seal the bonnet, not for seating. It isn't pinched or stressed when valve is closed. Independent disc gives control of fluid even should diaphragm fail. These valves are made in a wide variety of body, diaphragm, disc-insert, and body-lining materials to handle countless corrosive, abrasive, or ordinary services. See your Crane Catalog or local Crane Representative.

THE BETTER QUALITY... BIGGER VALUE LINE... IN BRASS, STEEL, IRON

CRANE VALVES

CRANE CO., *General Offices:* 836 S. Michigan Ave., Chicago 5, Illinois
Branches and Wholesalers Serving All Industrial Areas

VALVES • FITTINGS • PIPE • PLUMBING • HEATING

MILLION DOLLAR BABY at a bargain price

MANIPULATOR
The years of research which perfected this heavy-duty machine resulted in a new invention.

MANIPULET
Outgrowth of the Manipulator, this new device handles smaller pieces in less space and requires lower capital investment.

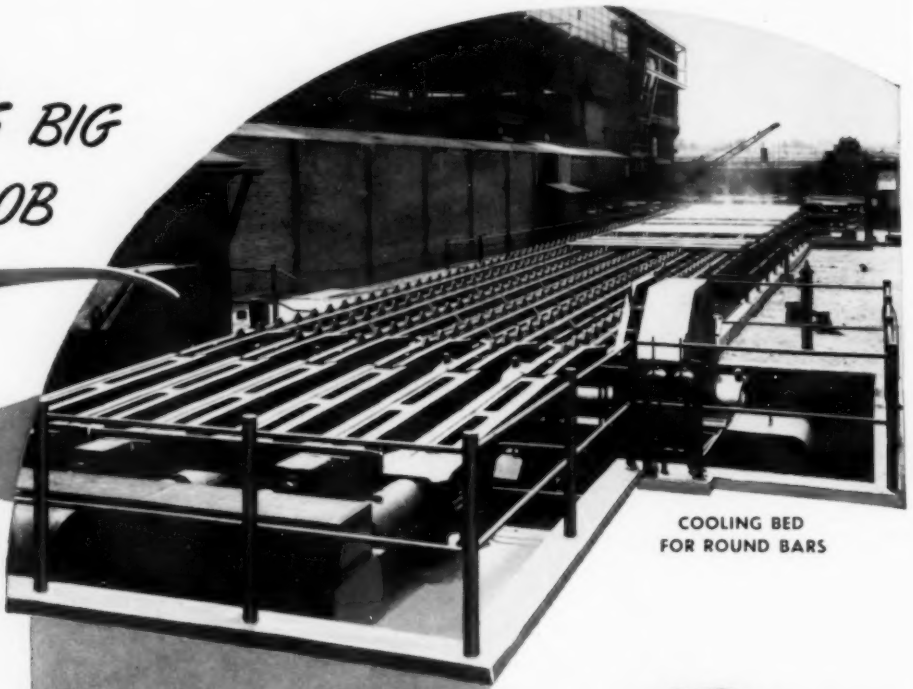
Salem-Brosius is proud to announce MANIPULET, an ingenious new device for furnace charging and drawing, transporting, and hammer or press manipulating of blanks and billets up to 1,500 pounds. This machine is literally the by-product of the many years of research which perfected its larger relative, yet is scaled down in cost to fit smaller and less arduous forging operations. It is truly a "million-dollar baby at a bargain price." Like the big Brosius Auto-Floor Forging Manipulator, its movements under hammer or press are extremely sensitive. It raises and lowers a forging piece, tilts it up or down, and rotates it . . . in fact, the Manipulet does everything possible with chain hoist and porter bar with far greater speed, safety and precision. Because of its unique ability to move into position, grasp and carry, while the operator remains at a safe distance, its use has already been suggested for handling other relatively heavy objects such as gas cylinders and boxes of radio-active material. If the Manipulet seems to fit your materials-handling problem—either forging or otherwise—please write to us for further information.

SALEM-BROSIUS, INC.

SALES AND EXECUTIVE OFFICES: 248 FOURTH AVENUE, PITTSBURGH 22, PA.

F&Y makes "what it takes"

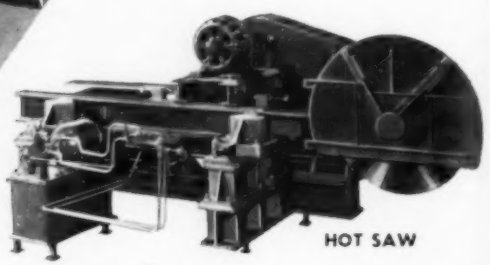
FOR INDUSTRY'S BIG PRODUCTION JOB



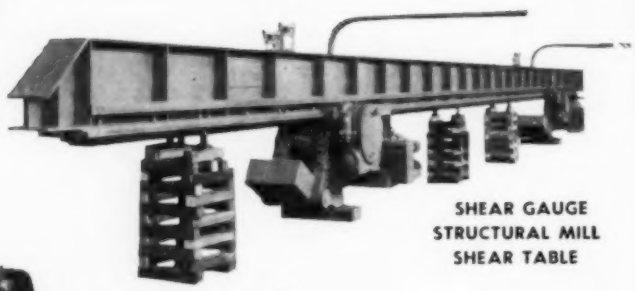
COOLING BED FOR ROUND BARS

F&Y Products

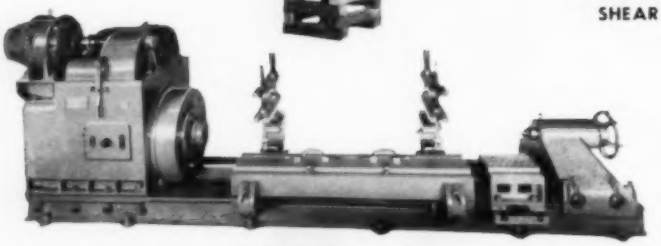
- PARALLOY ROLLS (PINCH, COILER, TENSION, STEEL MILL)
- HYDRAULIC SLAB AND BILLET PILERS
- STRIP AND SHEET OILING EQUIPMENT
- SHEET SCRUBBER AND CLEANING LINES
- HOT SAWS—ROCKING AND SLIDE TYPES
- HOT BEDS—COOLING BEDS—TRANSFERS
- BILLET EJECTORS—PINCH ROLL STANDS
- SLITTERS—SPECIAL SHEARS AND GAUGES
- TILTING TABLES—TRAVELING AND LIFTING TABLES
- CONTINUOUS PICKLING LINES—ROLLER LEVELLERS
- FURNACE CHARGING EQUIPMENT—FURNACE PUSHERS
- STRIP STEEL COILERS AND REELS—SCRAP BALLERS
- RAILROAD SPIKE FORMING MACHINES—ROLL LATHES
- SHEET GALVANIZING LINES—WIRE PATENTING FRAMES
- STRETCHER LEVELLERS—ANGLE AND SHAPE STRAIGHTENERS
- ROLLING MILL TABLES—GEAR AND INDIVIDUAL MOTOR TYPES
- DUCTILE CASTINGS (80,000 PSI)
- MACHINERY BUILT TO CUSTOMER'S DESIGN AND DETAIL DRAWINGS



HOT SAW



SHEAR GAUGE STRUCTURAL MILL SHEAR TABLE



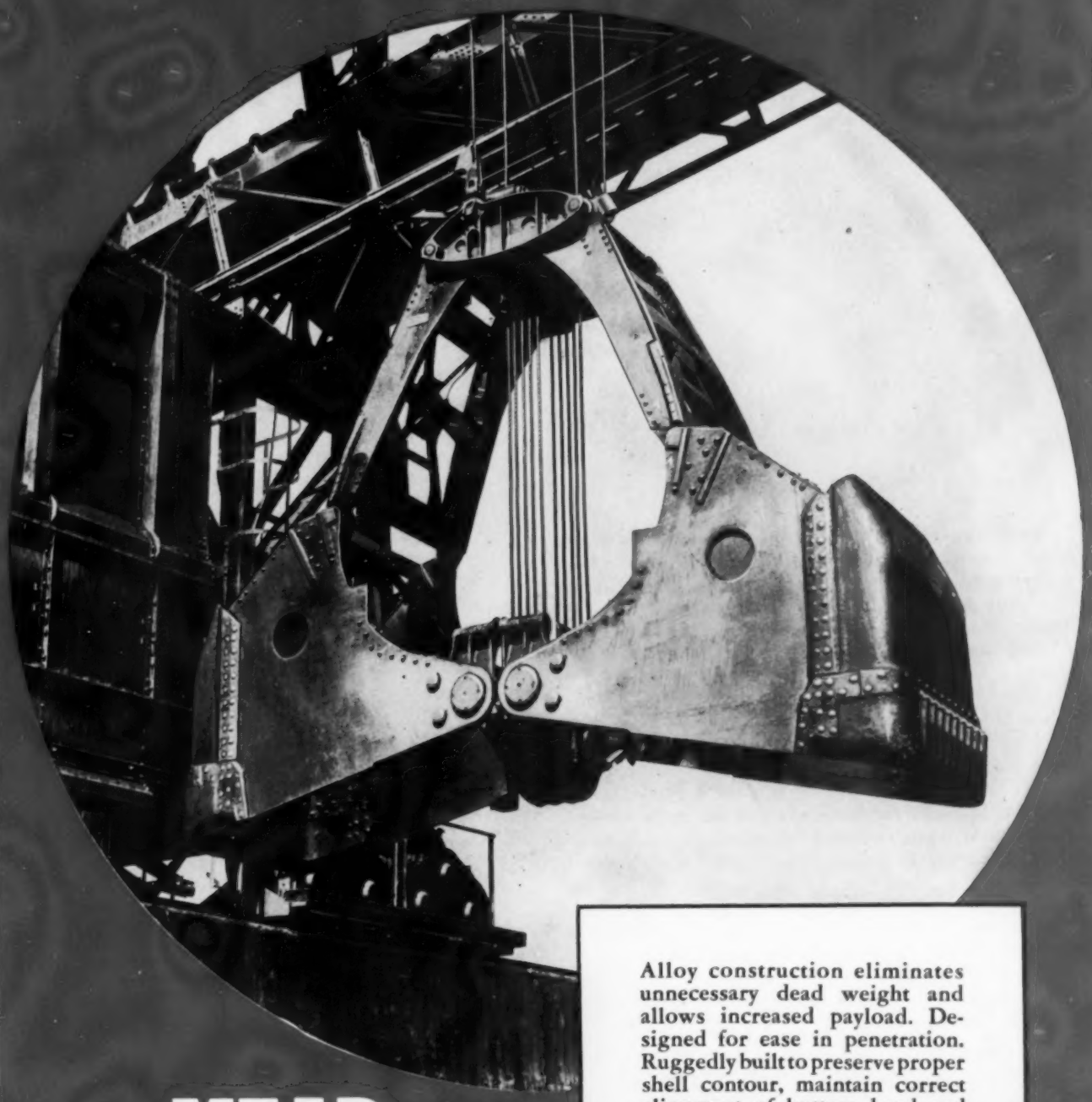
42" ROLL LATHE

The Youngstown Foundry & Machine Co.

OVER SIXTY YEARS OF SERVICE TO THE STEEL INDUSTRY

Youngstown, Ohio

MEAD-MORRISON Ore Buckets



Alloy construction eliminates unnecessary dead weight and allows increased payload. Designed for ease in penetration. Ruggedly built to preserve proper shell contour, maintain correct alignment of bottom head and shell and withstand operating abuse.

Designs to operate at ends of lines and bight of line in a range of sizes. Also clean-up grabs.

Write for full information.

MEAD-MORRISON

Division of

McKIERNAN-TERRY CORPORATION

Manufacturing Engineers • Harrison, N. J.

Also builders of coal and ore bridges, bulk material unloaders, pile hammers, and specially designed machinery

HERE'S VISUAL PROOF that JOY PLUGS are Distortion-Proof

Taken at one two-thousandths of a second, unretouched photo reproduced above shows a JOY 372M electrical connector absorbing the full impact of a heavily swung 10 lb. sledge hammer. Punished by twenty-four (24) similar blows while being so photographed the connector was then thoroughly tested for defects with results as reported at right.

When the problem is selecting electrical connectors for industrial applications and units in use *haven't quite measured up to requirements,* it's time to switch to JOY. Factory molded into one-piece Neoprene insulated units, JOY connectors can't crack or be smashed out-of-shape when dropped — won't become mushy when smeared with grease or oil — and are absolutely moisture-tight. Cork-like action of their Water-Seal also prevents metallic dust from accumulating around contacts when they're connected. Why accept less when the best actually *costs less* in the long run?

TEST REPORT

Date: 2-4-53 No. 387

OBJECT:

To determine the effect of heavy blows on a 372M connector.

PROCEDURE:

A 372M plug was selected at random from stock, placed on an anvil and struck 24 times with a 10 lb. sledge hammer. Impact force of each blow being approximately 40 foot pounds.

TEST DATA:

VISUAL INSPECTION: No distortion of original shape. Center pin slightly misaligned, however plug's ability to engage mating connectors unimpaired.

FLUOROSCOPE INSPECTION: Conductors intact and undamaged. No intermittent electrical opens in wiring.

ELECTRICAL TEST: 1500 volts AC RMS applied for 5 continuous minutes. Insulation between contacts did not break down.

COMMENTS:

JOY 372M plug relatively undamaged by blows described above. Should still render many years of satisfactory service under normal conditions.

Alfred V. Mucci

A. V. MUCCI
Supervisor Inspection

Ask for your free copy of this attractive two-color sixteen page Bulletin. Numbered MC108 it illustrates and describes many of the popular electrical plugs and receptacles JOY makes for Industry.

M.E. 353.3

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IN CANADA: JOY MANUFACTURING COMPANY (CANADA) LTD., GALT, ONTARIO

UNION

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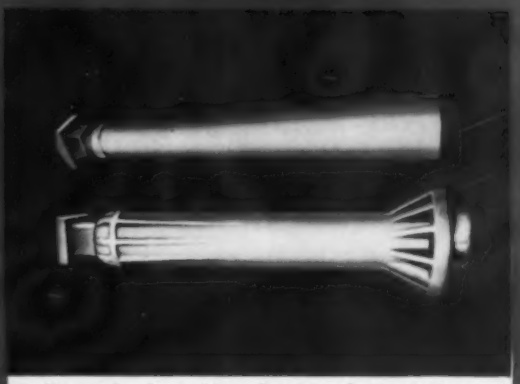

Heavy loads, sudden changes of temperature, torsional twists and shock are all in the day's work for "Union" Peels.

Universal Couplings and Spindles as cast by "Union" actually cost less... last longer... are easier to machine... require less down-time for replacement. Furnished in the rough or completely machined.

THERE'S NO DOUBT ABOUT IT. In every steel plant where UNIVAN boxes work alongside ordinary ones, they outlast them by *months!* This economical long life is due to the exclusive Double-Life Head plus a better casting design. When measured by tonnage handled and length of service you'll find "Union" the best buy *by far* . . . write for facts and figures.

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UNION STEEL CASTINGS DIVISION
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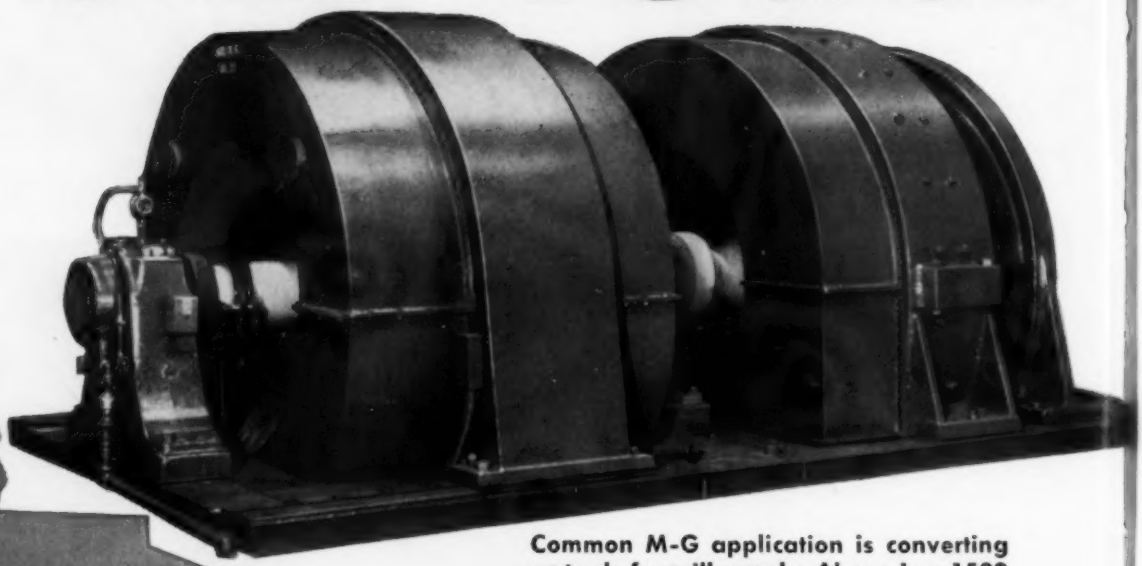
BLAW-KNOX

From Coast



Common M-G application is converting ac to dc for mill supply. Above is a 1500 kw synchronous set in eastern mill.

WEST

This 8-machine 2000 kw M-G set supports a two stand, four high tin temper mill with generators opposite their mill motors.

MIDWEST

A 56-inch, four stand tandem cold reduction mill is supported by this 7-machine 7750 kw synchronous motor-generator set.

EAST

Three 3-machine 6000 kw synchronous M-G sets supporting six finishing stand motors in a large East Coast steel rolling mill.

TEMPER MILL

Three midwestern single stand temper mills are supported by these M-G sets. Synchronous motors of 1750 hp drive each set.

to Coast!

ALLIS-CHALMERS M-G SETS ARE WIDELY USED IN SUPPORT OF STEEL MILL DC DRIVES

MAJOR STEEL PRODUCERS from Coast to Coast use Allis-Chalmers motor-generator sets. This nationwide acceptance in heavy duty service is proof of their durability and quality.

These representative M-G sets indicate the wide variety in design and size available. Allis-Chalmers has long experience with steel mill needs — having built M-G sets for all current applications — and will build special for any new requirement that may arise.

Motor-generator sets give you:

1. Power factor correction.
2. Regenerative braking.
3. Quick starting for emergency demand.

Only Allis-Chalmers gives you M-G sets with the exclusive *Frog-Leg* armature winding that ***eliminates injurious commutator sparking.*** *Frog-Leg* winding connects bars of equal potential through the winding itself . . . producing a perfectly equalized winding without the use of cross-connectors.

For full details on this heavy duty steel mill rotating equipment, ask for M-G Set Bulletin 05B6032A and Large DC Motor Bulletin 05B6002A. For your copies, just call the nearest A-C office or write direct to Allis-Chalmers, Milwaukee 1, Wisconsin. A-3920

Frog-Leg is an Allis-Chalmers trademark.

PICKLING LINE

A pickling line in an eastern steel mill is supported by this 4-machine 1375 kw, 720 rpm synchronous M-G set.

RECORD BREAKER

A motor room, completely equipped by Allis-Chalmers, powered this 80-inch western hot strip mill to a new annual world tonnage record.

ALLIS-CHALMERS

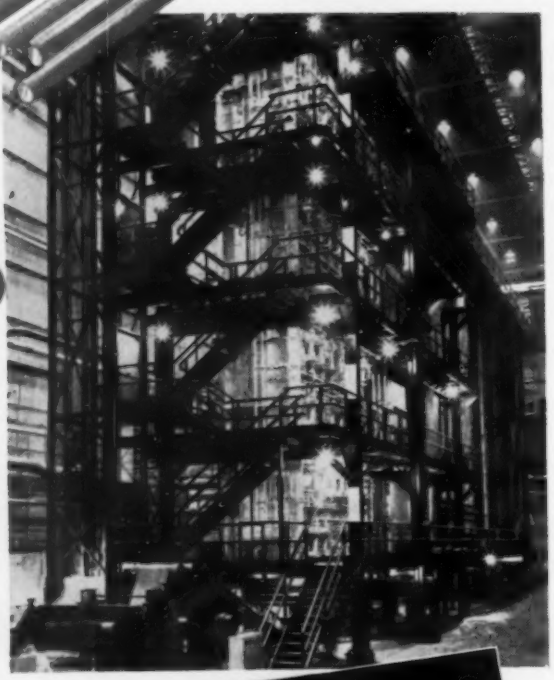
Power, Electrical, Processing Equipment for Iron and Steel

Improved product

Reduced finishing costs

Greater customer acceptance

Finished steel quality control is the goal of every Steel Maker. Steel finishing under precise atmosphere control is the answer. It assures premium quality at lower ultimate cost. Some applications of these "Surface" generators are described below.



1

BRIGHT ANNEALING, STRIP

1 — *Continuous bright annealing of strip,* for tin plating, is carried out at high speeds in this vertical strand furnace. NX or HNX atmosphere can be used.

2 — *Batch bright annealing of coiled strip* is accomplished in lift cover furnaces of the type shown. In this single row installation, NX protective atmosphere is used.

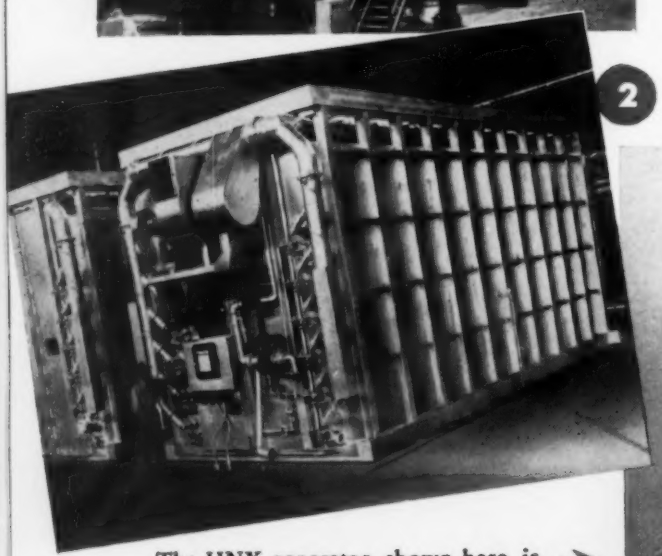
CARBON CORRECTION, BAR STOCK

3 — *Batch carbon restoration* utilizes this lift cover, carbottom type furnace for simultaneous skin recovery and clean annealing. Here again, the reactive carbon medium is enriched RX atmosphere and the protective medium is NX atmosphere.

4 — *Continuous production carbon restoration of bar stock* is accomplished in this roller hearth furnace in conjunction with clean annealing. Enriched, RX atmosphere, is used as the carburizing medium and NX atmosphere for surface protection.

BRIGHT ANNEALING, SHEET

5 — *Continuous bright annealing of stainless clad sheet* in this disc hearth furnace with special rapid air quench chamber utilizes a protective atmosphere of DX gas.



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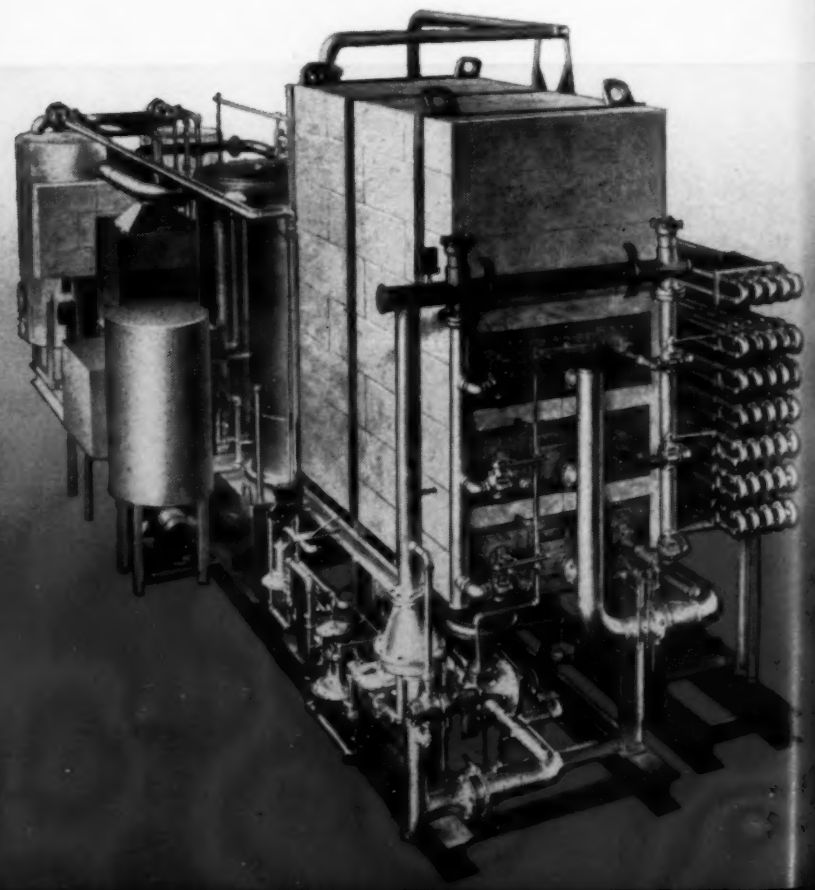
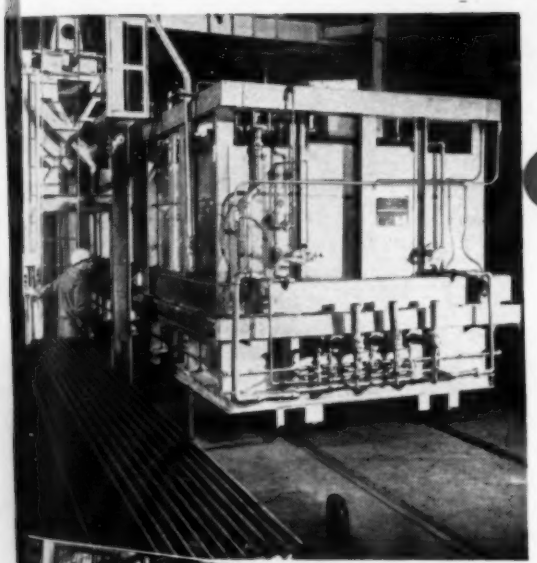


The HNX generator, shown here, is one of the five principal atmosphere generator types—RX, DX, NX, AX—built by Surface Combustion. They represent the engineering skill and 'know how' of 40 years standing in serving the nation's steelmakers. They make finished quality steel a practicality.

For complete information on the applications of these atmospheres, write for Bulletin SC-155.

YOU GET ALL 3 WITH *Surface*

CONTROLLED ATMOSPHERE



3

4

5

FURNACES AND GENERATORS

Controlled atmospheres have opened up endless possibilities throughout the Steel Industry for the safeguarding of product quality and increasing customer acceptance. Case carburizing...dry cyaniding... homogeneous carburizing . . . carbon restoration . . . clean hardening . . . bright or clean annealing . . . galvanizing . . . are among the important finishing operations, which come under its influence. These can be accomplished faster and with far better results using controlled atmospheres than by direct heating methods.

'*Surface*' has contributed materially to the success of controlled atmosphere in the Steel Industry. '*Surface*' Furnaces and Generators have given controlled atmosphere processes full production status at a time when increased tonnage plus an improved product are vital.

Into the design and construction of 'Surface' Controlled Atmosphere Furnaces and Generators have gone the best engineering talent available. Each atmosphere type has been developed to 'shoulder' a definite set of responsibilities in the treatment of steels (or non-ferrous metals) and to do its job well. Nothing has been overlooked to make 'Surface' the "buy word" in dependable controlled atmosphere equipment and its applications.

'*Surface*', acknowledged as a great name in the Steel Industry for over a quarter-of-a-century—with hundreds of successful Steel Mill installations to its credit—invites you to share in its experience and 'know how' in the interest of quality . . . an improved product at worthwhile savings.

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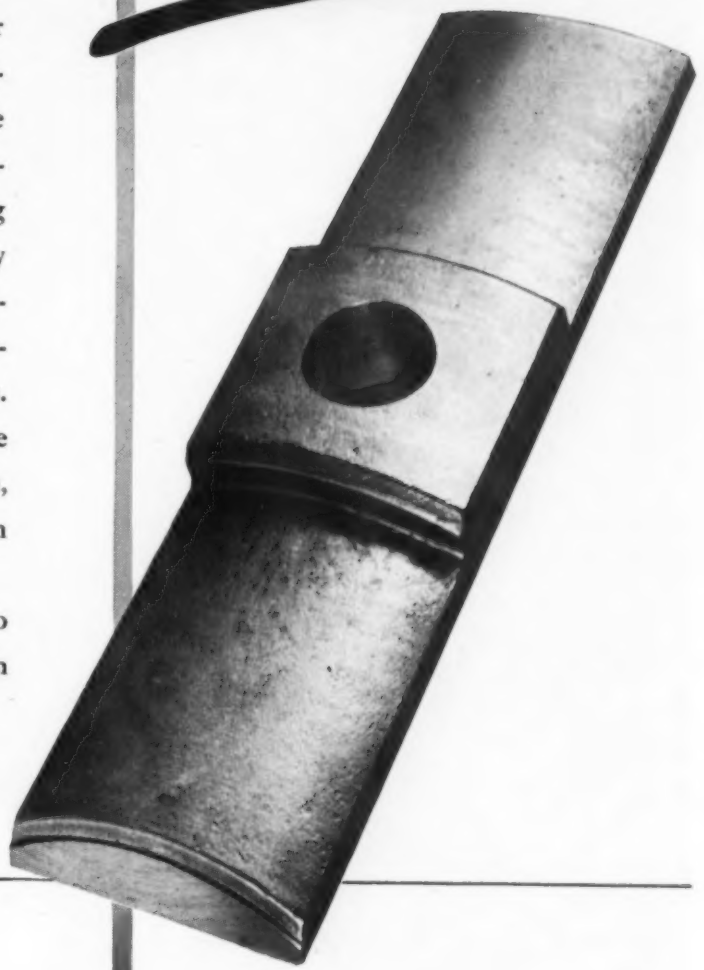

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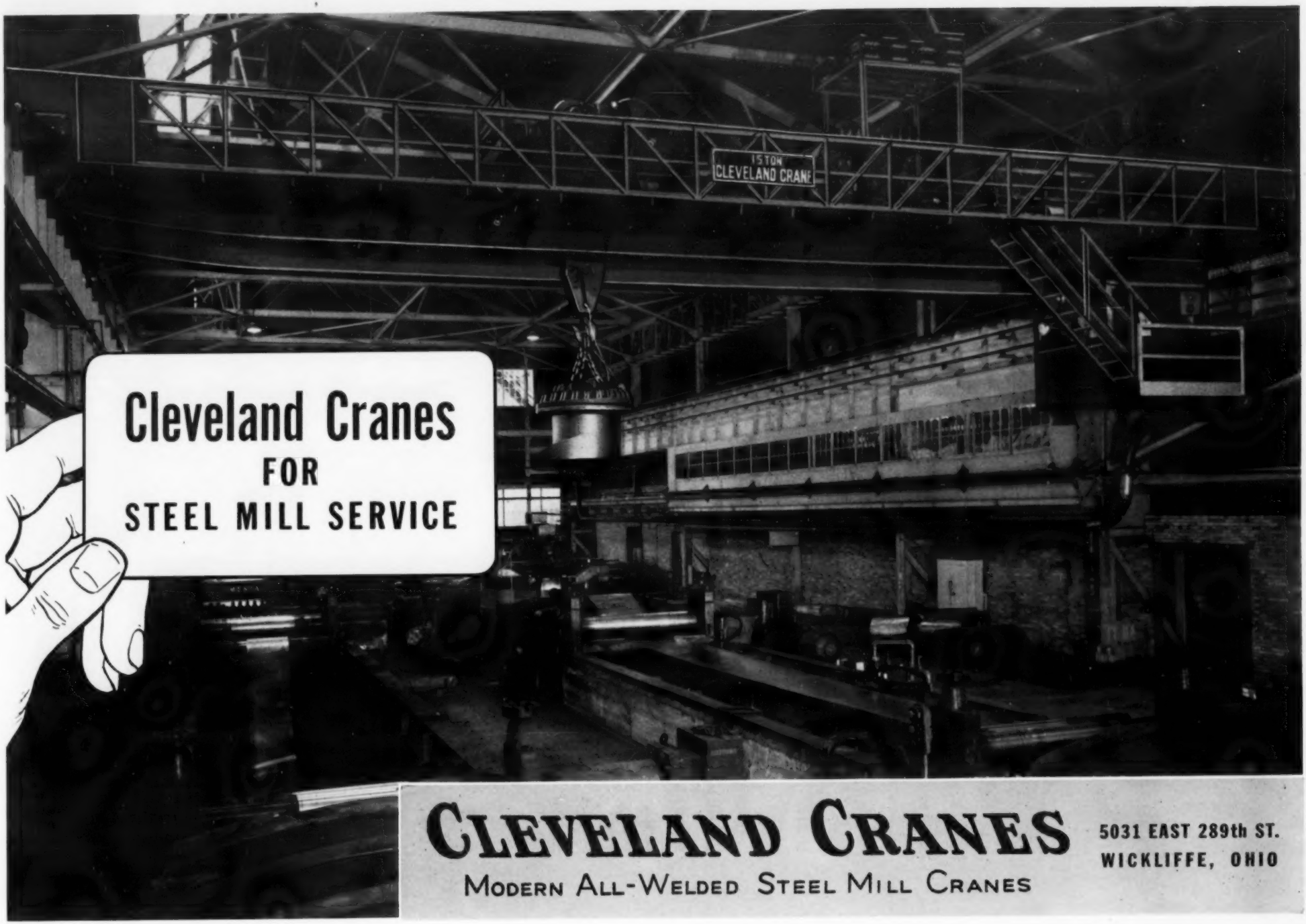
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Crops *and* Shorts

THIS year's graduates from engineering colleges are being swept off their feet by the competition for their services when they leave school. With several openings for every graduate, starting pay in some cases approaches the fantastic, and many are enjoying all-expense-paid trips around the country for interviews. Some of these interviews even include introductions to local young ladies who, it is hoped, might so fascinate the young men that they will sign up.

Indicative of the intense competition is the unique move by Bethlehem Steel Co., who has offered 45 private colleges $3000 for each graduate of the institutions who is hired by the company for its training course and stays with the company at least four months.

Pretty soon the graduates will, like outstanding baseball prospects, receive bonuses for signing.

▲

THE effects of last year's strike are emphasized by the net earnings of the 30 principal steel producers, which totaled $502,144,737 in 1952 as compared with $646,185,883 in 1951. Incidentally, our federal government was the major strike sufferer, as the same 30 companies paid $789,000,000 less federal taxes in 1952 than in 1951. This exceeds the half-billion dollars lost in wages by the strikers.

Reports for the first quarter of 1953 show steel company profits in general, but not in all cases, to be higher than the corresponding period of 1952.

▲

POINTING out the advantages of free America, the Wall Street Journal says that a street sweeper can become a professor — if he's willing to make the financial sacrifice.

▲

A correspondent reminds us that a lot of today's juvenile delinquency is merely a modern term for what we did when we were kids.

▲

REPORTS of reserves of zinc ore and of their development indicate a steadily increasing production of zinc, provided the market and price level are favorable.

▲

SPEAKING before a convention of industrial trade associations, B. F. Fairless, chairman of United States Steel Corp., said that the American Steel industry is suffering from "a clear case of financial malnutrition," arising largely from government regulations which, since 1940, have boosted employment costs 155 per cent and raised the price of goods purchased 138 per cent while allowing only an 87 per cent increase in the price of steel. He said that, in spite of a 25 per cent expansion in steelmaking facilities and a 35 per cent increase in steel shipments over the past 12 years, U. S. Steel's profits, in terms of actual purchasing power, have equalled the 1940 profit in only two of the 12 years.

This speech apparently keynoted the thinking of the industry, which became evident about May 1 in announcements of higher prices for extras.

▲

ACCORDING to the American Iron and Steel Institute, more companies are making steel now than 14 years ago, in spite of mergers and other changes. Steel ingot producers now total 84 companies, a net gain of 11 since 1939.

Some of the changes in the size of companies are shown in the following:

Annual capacities, net tons	No. of companies 1939	1953
1,000,000 and over	11	16
500,000 - 999,999	8	11
250,000 - 499,999	11	8
100,000 - 249,000	10	12
50,000 - 99,999	7	15
25,000 - 49,999	6	12
Under 25,000	20	10
	73	84

▲

TEEN age has been defined as the interval between pigtails and cocktails.

▲

TOTAL employment in the iron and steel industry in February was estimated at 684,900 persons, a new record. Wage earners averaged $2.208 per hour.

▲

A correspondent tells us that, in the "good old days," women saved their wedding dresses for their daughters instead of for their next wedding, and marriages produced triangles on the clothes-line instead of in the courtroom.

Yeah, and they used to take our shirt in the stock market rather than in the supermarket — and it was easier to find a needle in a woman's hand than in a haystack.

▲

THE U. S. Department of Agriculture has announced the development of a speedier method for the manufacture of cheese, enabling cheese makers to double their output.

At the same time, the same department, because there is too much cheese, is buying about 22,000,000 pounds per month at 37 cents per pound to support the price. They don't want to cut the price, but are considering giving a bonus of cheese with each amount bought. Shades of the same old "deal"!

▲

FAR be it from us to minimize safety, but if a safety man had been around, Ben Franklin wouldn't have been allowed to perform his famous kite experiment.

Right: Two 5000 hp main drive motors (at rear) are direct-connected through spindles to the top and bottom rolls. Exciter sets (foreground) provide adjustable a-c power to excite field windings of main drive generators and motors.

World's fastest reversing blooming mill powered by Westinghouse

Jones & Laughlin's new 46-inch, high lift blooming mill at Pittsburgh owns the world's record for fast reversal. In just one second, the 10,000 hp twin motor drive reverses from 40 rpm in one direction to 40 rpm in the other direction. Two giant motors turn smoothly at full base speed, and one second later—with no visible strain, no perceptible vibration —they're whirring with equal calmness in the opposite direction.

"Without a hitch". "This mill went into operation without a hitch," says George Kaufman, J & L's Chief Electrical Engineer. "Westinghouse Steel Mill Specialists worked with our engineers and the mill builder from the first. As a result, operation of the mill more than met the requirements of our engineering and operating departments."

At first, too fast. For fast reversals of the main roll motors to be of value, the auxiliaries (main roll screwdowns, mill table motors and manipulators) must also act rapidly. Proof that they do was shown in early tests. The manipulators, on the first try, operated so quickly that a ten-ton ingot was flipped completely over—180 degrees instead of 90.

Rototrols® speed operation. Rototrol regulators provide high forcing voltages to the mill auxiliary-generators and the main drive exciters. Due to the co-ordinated design of the regulating system, auxiliary-generator voltages are reversed in less than one second. Forced by fast voltage charges, the drive responds instantly to the operator's flip of the master switch.

Next time, call Westinghouse. Imaginative, dollar-saving engineering like this can be applied to *all* steel mill problems. When your next job comes up, take advantage of Westinghouse experience in steel—the widest in the electrical industry. Call your nearby Westinghouse office early in the planning stage. Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-94987

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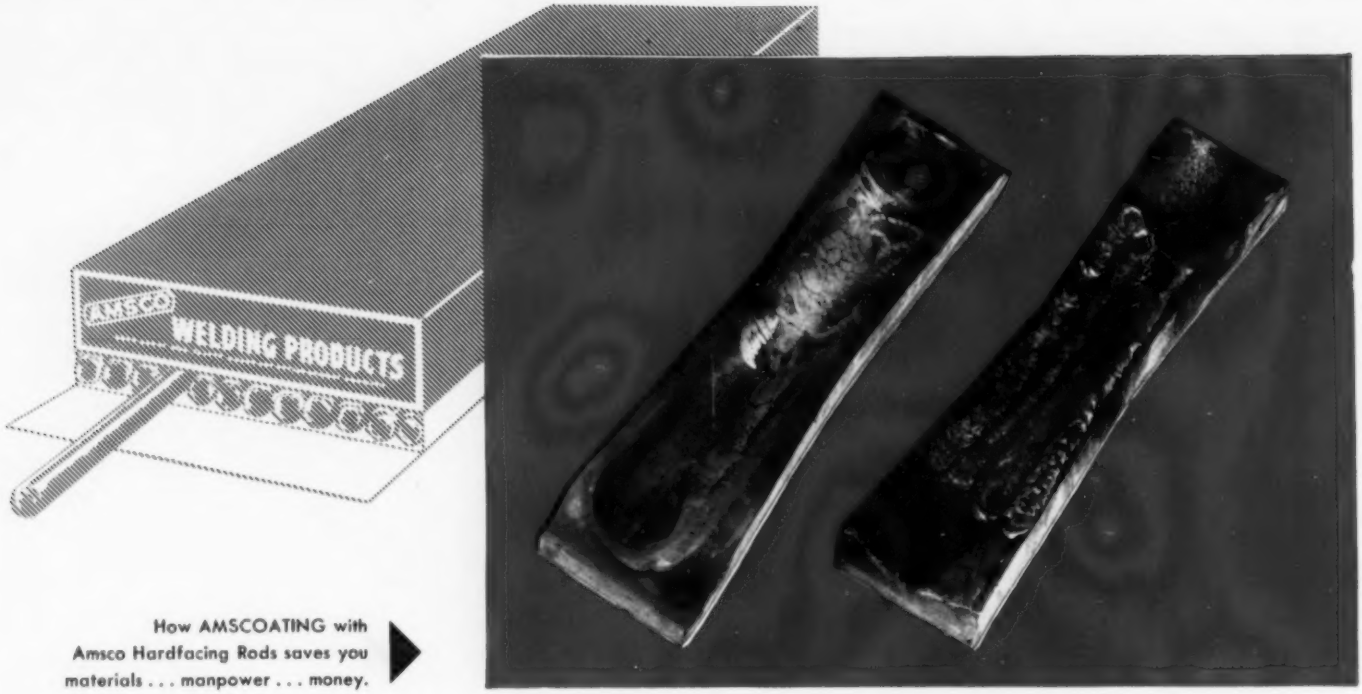

How AMSCOATING with Amsco Hardfacing Rods saves you materials . . . manpower . . . money.

Amscoating these guide shoes kicks tube production up

AMSCOATING . . . stands for control of wear by Hardfacing . . .

Hardfacing Rods—and recommendations for their use—are as sound as the manufacturer who makes them. AMSCO has been fighting wear for a half-century—first with Manganese Steel, and later with AMSCO Hardfacing Products.

If you have a problem of wear caused by impact, abrasion, heat or corrosion . . .

Find out how AMSCOATING can save you materials . . . manpower . . . money!

Continuous production, greater safety and better weldability are three *good* reasons for Amscoating Piercer Guide Shoes.

These Piercer Guide Shoes are used at a large midwestern steel plant to hold a rotating hot bar in alignment during the initial piercing operation. Wear was not the main problem here. The condition to be avoided was "pick-up", where the bar becomes fused with shoe and literally explodes.

To lick this problem, which can result in expensive equipment damage and loss of life, the welding superintendent chose Amsco Thermalloy No. 4 for three reasons:

1. **Complete elimination of pick-ups . . . for greater safety and higher production**
2. **Better weldability . . . Thermalloy No. 4 covers heat checks, prevents small cracks that can cause pick-ups or seizing.**
3. **Amscoated shoes can be used many times . . . for big savings in replacement costs over a year's period.**

AMSCOATING permits big savings—through longer service and fewer replacements—on many other applications. If you have equipment that's subject to wear, the possible savings to you—are too big to be overlooked!

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PLASTIC BINDING U. S. PATENT NO. 1970285 LICENCE NO. 120

MASTER SWITCHES
for speed control

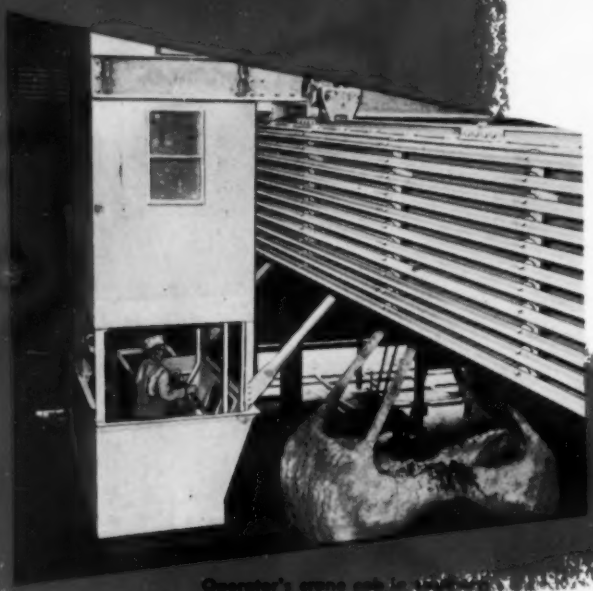
Operator's cab of river barge unloader

EASY TO OPERATE
A BIG AID TO PRODUCTION

For sit-down, full view cabs or at stations where the operator stands up, several EC&M Master Switches can be compactly grouped within easy reach of the operator without the use of bell-cranks or chain-sprockets. Short in throw and narrow in width, these Cam Master Switches are less tiring on operators—the swifter, easier flow of output means more profit.

Individual speed point notches are readily felt with the off-point most noticeable. Inching between "off" and first point in either direction, too, is easy.

EC&M builds these Cam Master Switches with 2, 3 or 4 cams to provide ample circuits to suit the application.



Operator's crane cab in [illegible]

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Pass Design for Hexagons

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. . . . present high delivery speeds and production rates of the modern bar mill require both refinements in design and flexibility for size changes . . . .

▲ THE relative importance of hexagons as a bar product in the present day scheme of things can hardly be overlooked. Three 10-in. bar mills with high production report that hexagon bars are 3, 5 and 17 per cent of their annual production.

The hot rolled size range for the industry is approximately ¼ to 3 9/16 in., although regular published sizes range from ⅜ to 3 3/16 in. advancing by thirty-seconds and sixteenths. Bar mills, as a rule, roll only part of this range depending on mill size and demand.

The largest part of all hot rolled hexagon bars are cold drawn before machining. Ultimately bolts, nuts, socket wrench parts, pins, spark plugs, conveyor parts, hose fittings, aircraft parts, grease fittings, etc., are manufactured from hexagon bar stock. Because much of the machining of products derived from the hexagon shape takes place in automatic screw machines, free machining steel specifications usually apply. The steel grades in which hexagon bars are most commonly furnished are soft open hearth, resulphurized bessemer, resulphurized open hearth and lead bearing.

Of the material to be cold drawn, the smaller sizes, usually below ¾ in., are ordered as coiled material for drawing on bull blocks. Larger sizes are rolled in hot bed lengths for draw benches.

The problems encountered in the rolling of hexagons must be resolved by producing a quality acceptable to the trade without sacrificing mill production rate. In addition to adherence to dimensioned tolerances, it is necessary to maintain standards of surface quality, sharp corners and freedom from twist. With the exception of surface quality, all these objectives are totally under control in the finishing mills. To attain the desired results, a combination of good pass design and operating technique are required.

THE ROLL PASSES

The determining factors influencing the adoption of particular pass sequences are:

1. Mill arrangement.
2. Standard roughing passes.
3. Size of section.
4. Size of mill.
5. Customer requirements.
6. Steel grades.

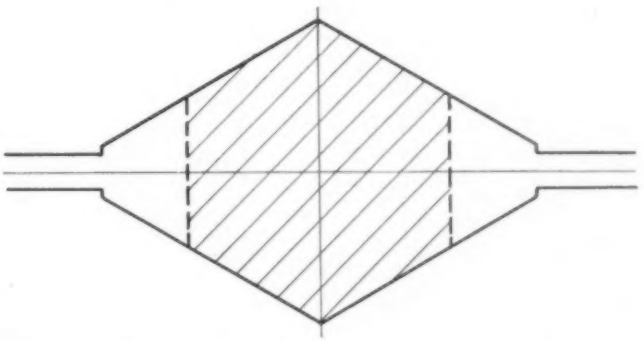


Figure 1 — Rolling the finishing pass parted at flats is the most popular method.

The development to follow will trace the pass designs from the finishing pass to the forming passes for two rolling methods.

The relative merit of these methods are a matter for controversy, but the topic will be treated objectively without regard for personal opinion. The methods are, descriptively:

a. Finishing pass parted at the flats (Figure 1).

b. Finishing pass parted at the corners (Figure 2).

Method "a" appears to be the most popular. The following remarks may weigh for or against the designated methods.

Method a (Parting at flats).

1. A number of sizes can be rolled on the finishing pass by adjusting the rolls.
2. Roll and pass life is greater, at least of the finishing set, because of this flexibility.

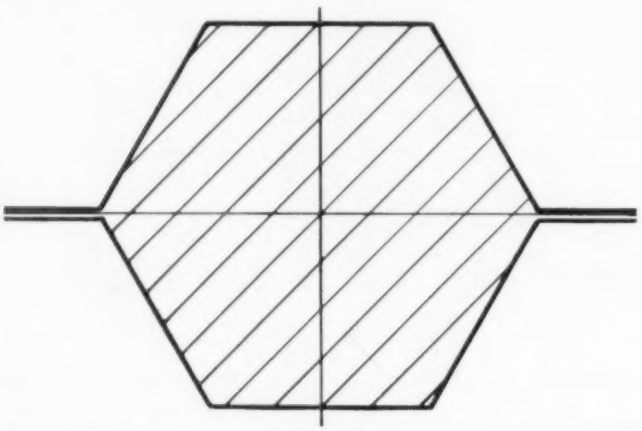
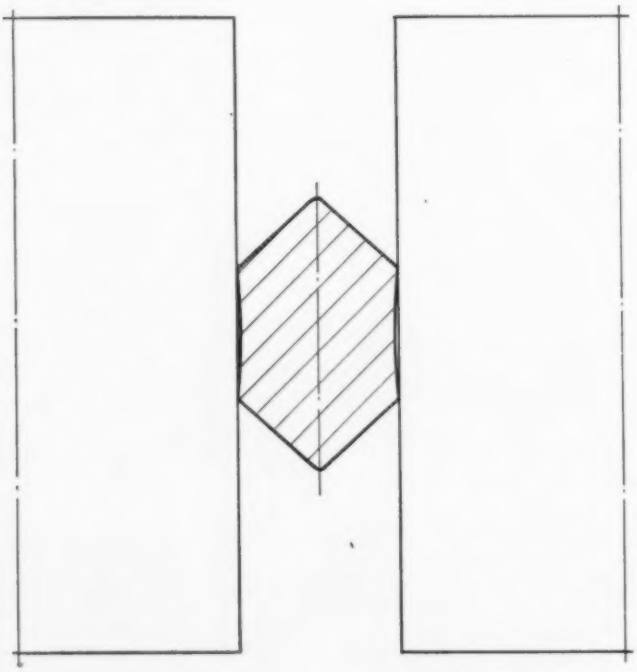


Figure 2 — Rolling the finishing pass parted at corners is the second generally used method of rolling hexagons.

3. Sharp corners develop easily.
4. Dimensional variations due to temperature gradients in the bar are absorbed without tendency to underfill or overfill.
5. Dimensions of the flat surfaces, however, may not be uniform nor is the angular relationship between flats necessarily exact.
6. It requires a good mill set-up to maintain finished bar dimensions within tolerances.
7. There is a difference in surface texture between the rolled sides and the open, unrolled, sides.

Figure 3 — A flat roller guide is used with a finishing pass parted at the flats.



Method b (Parting at corners).

1. Open corners may vary from slightly round to a slight overfill from end to end of bar and from side to side.
2. If temperature is not uniform and guide and roll set-up is not correct, delays may result in trying to obtain and hold section.
3. Dimensions of flats, however, will be uniform as well as the angles between flats.
4. Individual passes must be maintained for each size. Each size requires a move over.

Either of these methods of finishing derives beneficial results from the use of roller entry guides. Figures 3 and 4 illustrate the application of roller entry guides to the finishing pass. Figure 3 shows how a flat roller is

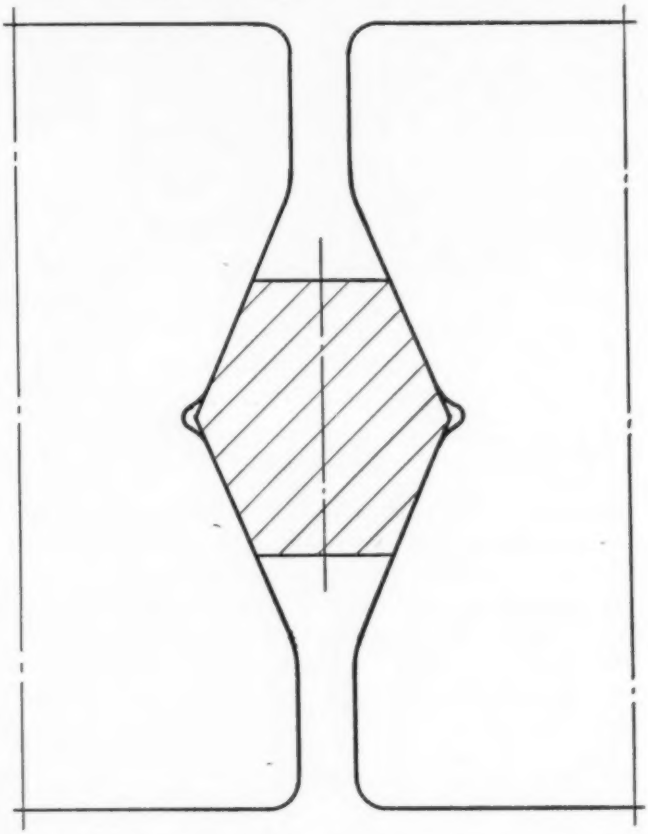
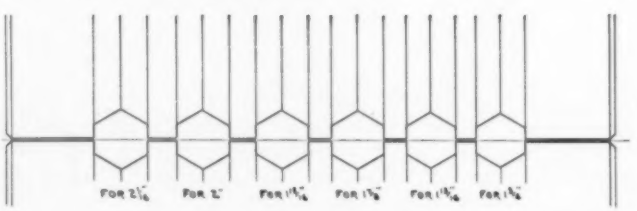


Figure 4 — A V-groove roller is used with a finishing pass parted at the corners.

used with a finishing pass parted at the flats and Figure 4 shows how a V-groove roller is used with a finishing pass parted at the corners. The rollers insure a tight scratch free guide set-up. Roller entry guides are also used with earlier passes.

In order to avoid confusion, the discussion of pass

Figure 5 — Hexagon finishing rolls, turned with corners and "snug" passes, are used on a 12-in. cross country mill for 1¾ to 2 1/16 in. sizes.



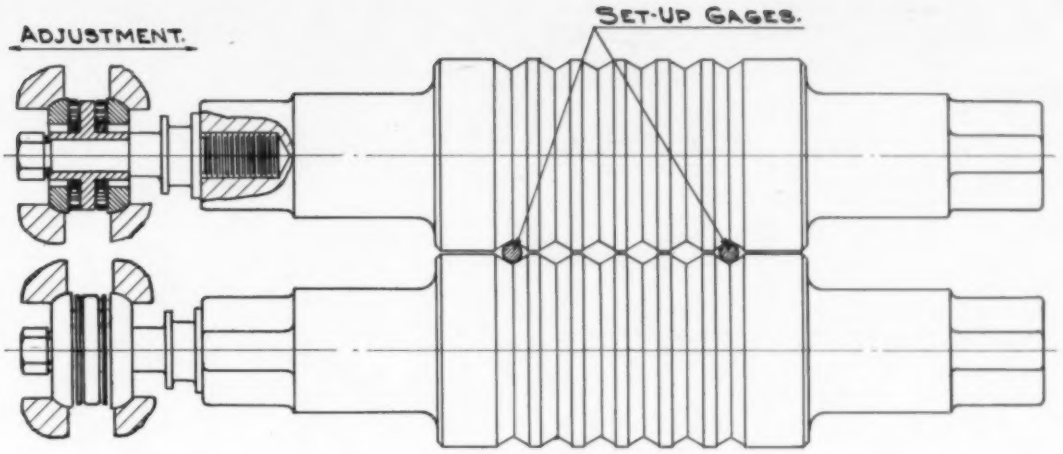


Figure 6 — These hexagon finishing rolls are turned with shallow passes for sizes from 1 7/32 in. to 2 1/16 in.

development will from here on be segregated according to the two methods already designated as "a" and "b."

PASS DESIGN — FINISHING PASS PARTED AT FLATS

Finishing pass — In prevailing practices there are at least two ways of turning the finishing rolls for the

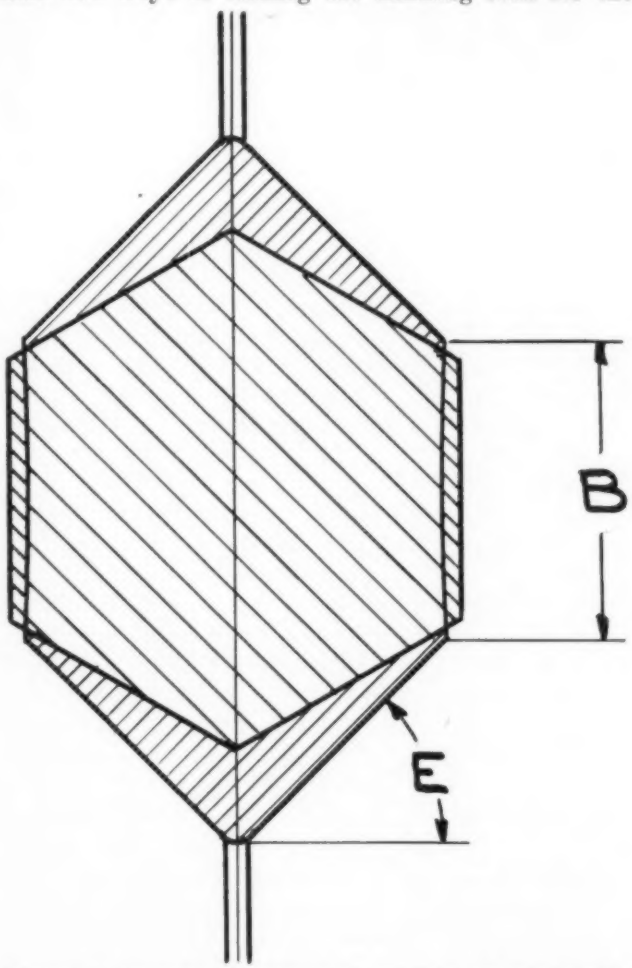


Figure 7 — Sketch shows a superimposed leader and finishing pass for rolling method with parting at flats.

method parting at flats. Figures 5 and 6 contrast two such arrangements. Figure 5 illustrates a set of hexagon finishing rolls turned with collars and "snug" passes covering the range of 1¾ to 2 1/16 in. on a 12-in. cross country mill. Figure 6 shows the same roll size for this mill turned with shallow passes in order to cover a size range of 1 7/32 to 2 1/16 in. Not only is the range wider for the case of Figure 6, but every pass is capable of rolling the whole range until worn out. In order to insure pass registration, rolls should be turned with spanning templets. In the mill, rolls can be aligned with round bar gages for a precise setting.

Axial adjustment of rolls for correcting pass alignment is accomplished very satisfactorily by means of an outside mounted roller thrust bearing. Figure 6 also shows how such bearings are applied at the finishing rolls.

Leader pass — The geometry of the leader pass is peculiar to this method of finishing the bar. A superimposed leader and finishing pass are shown in Figure 7. There are several design characteristics which are variable in laying out such passes. Due to the fact that invariably not one size but passes for a whole range must be designed, it will be shown how this can be done with some assurance of consistent results. Differences in pass design result in differences in percentage of area reduction and percentage of displaced metal displaced into spread. The designer may use two principal dimensions in order to control the reduction. These are the dimension B, Figure 8, which determine the work on the free side, and the angle E which determines how much of the draft will occur at the center or apex position. In practice the angle E varies between 35 and 45 degrees. Examination of the curves of Figure 8 reveals that work at position B is a function of the bar size and varies inversely with the bar size. Figure 8 has been plotted from actual pass calibrations. These tend to show slight inconsistencies, probably due to spot revisions. The data suggests a rational method of developing a family of designs once the pattern has been determined by the designs for the extremes of the range. The variation of the leader apex angle designated as, "E," is shown by Figure 9. A tendency for angle "E" to diminish for the larger bar sizes is indicated. This is believed to be consistent and in the right direction, since reduction should vary inversely with bar size. The angle should be acute to a degree to insure formation of sharp corners at the top and bottom of the bar with enough draft to stabilize delivery. The development of sharp corners at the sides of the bar depends on adequate draft at "B" as well as concavity at this position in the leader. The required concavity is dependent upon the draft and size of bar. Due to the fact that both of these variables enter into

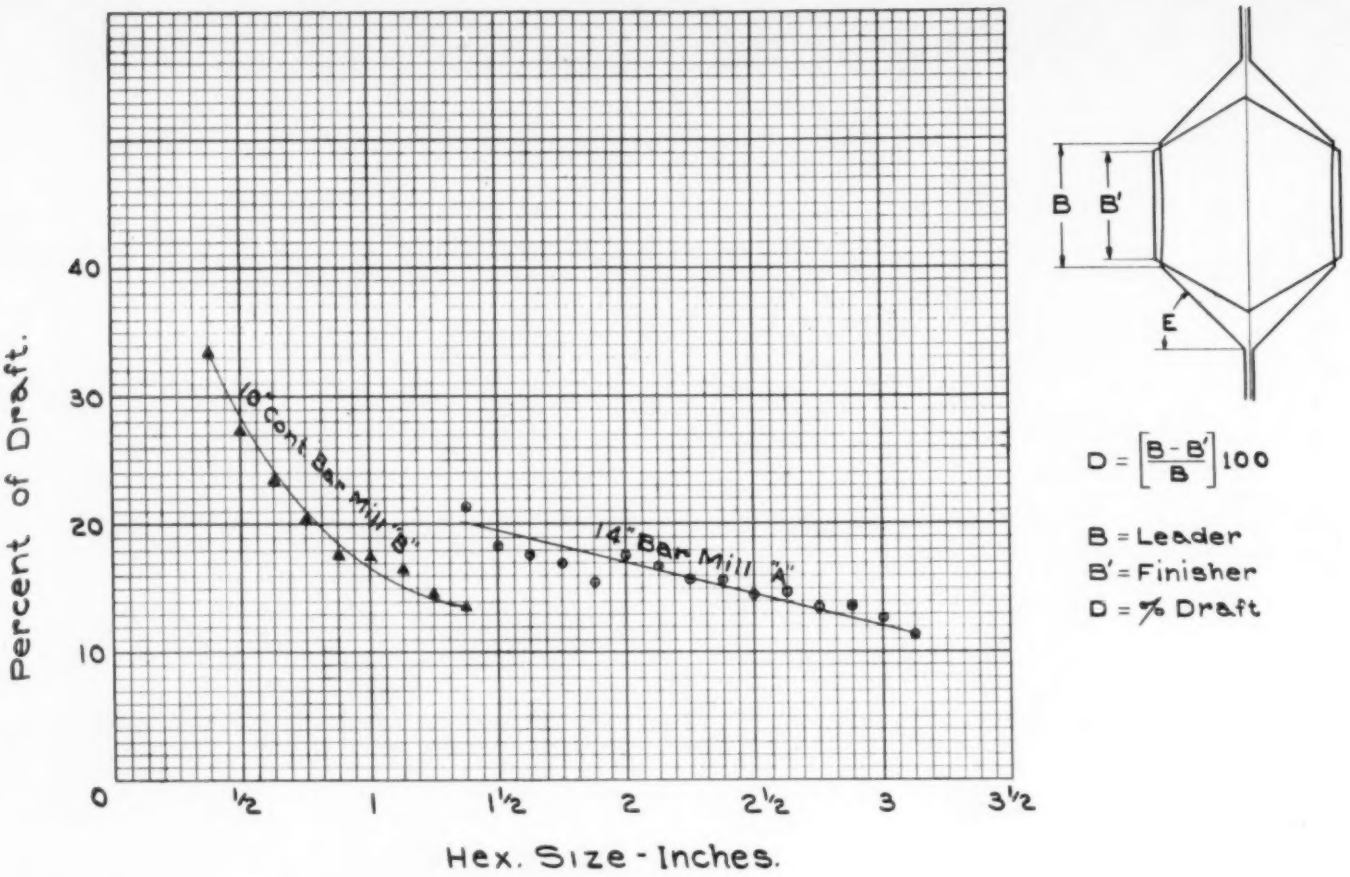
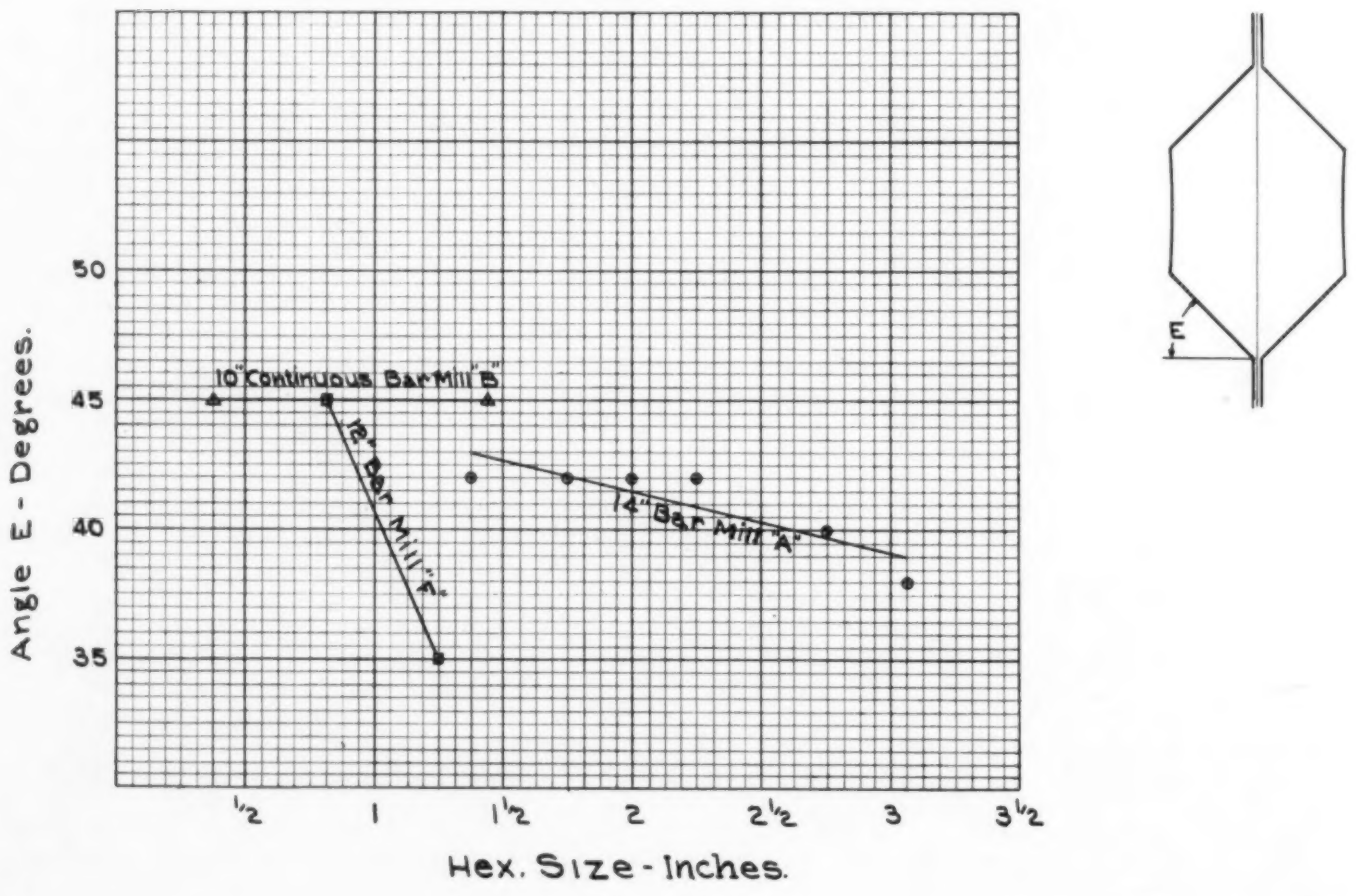


Figure 8 — Curves give data for draft at sides required for different bar sizes.

Figure 9 — Curve shows apex angle of leader for various bar sizes.



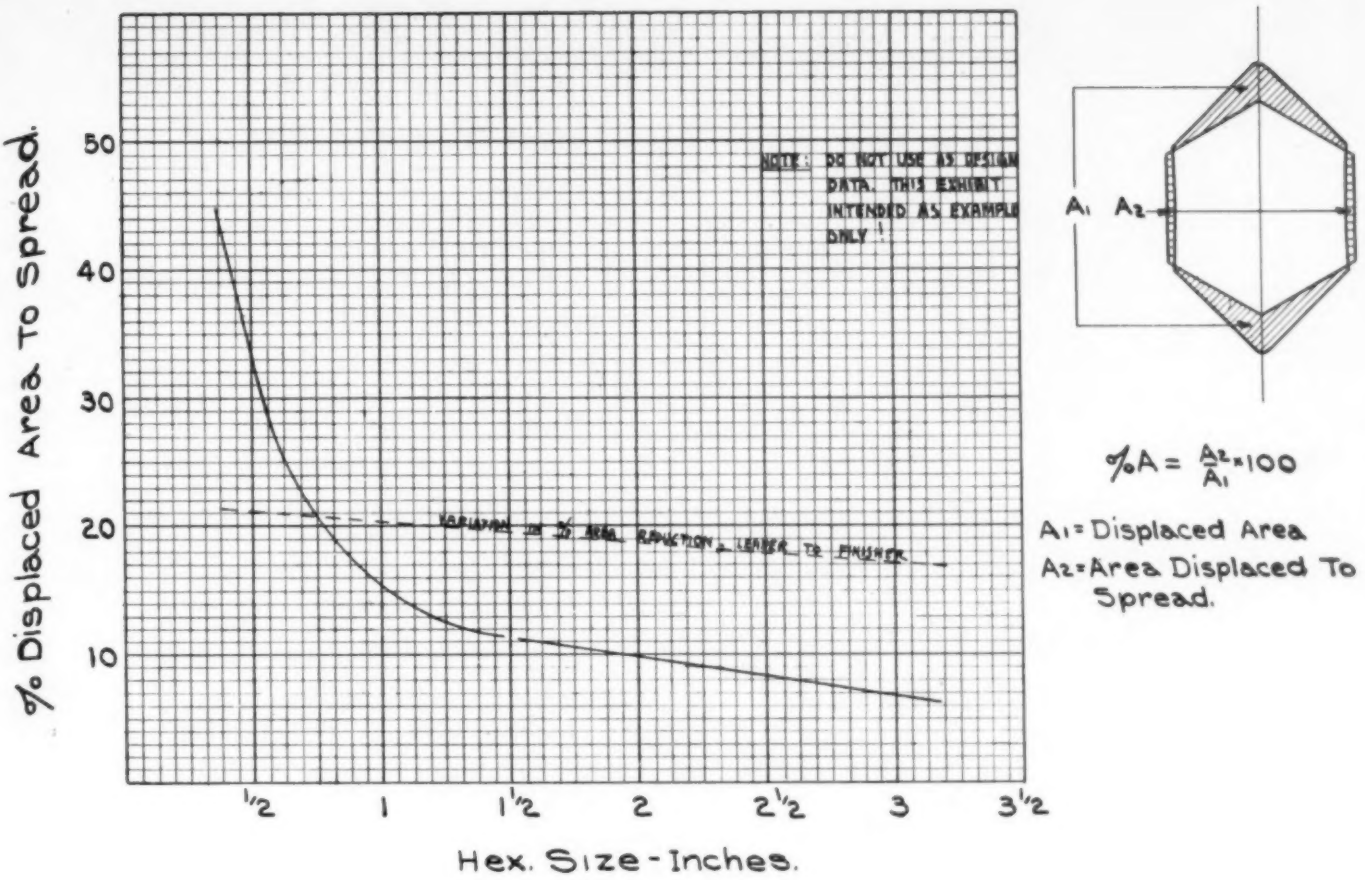


Figure 10 — Curves give ratio of per cent area displaced to spread for various bar sizes.

determination of concavity, no precise relationship can easily be predicted. With moderate drafting, concavity will vary from 0.005 to 0.011 in. For heavier drafting, concavities up to 0.031 in. may be in order. If the designers judgment is good, a minimum amount of trial and error corrections will be necessary. In proportioning passes for a size range, there should be an inverse relationship between concavity and bar size.

After the principal proportions of leader passes has been determined, that is, face width, angularity and concavity, the only remaining decision involves the roll parting and pass depth. The roll parting should be kept as small as possible within practical limitations, so as to form a sharp apex. It may vary from 0.031 to 0.093 in. depending on section size and mill size. Actually the rolls must be adjusted to deviate from the theoretical parting in order to make section.

The depth of pass is determined by an estimation of the spread. Referring again to Figure 7, the superimposed leader and finished section, it is observed that the area displaced into spread is a fraction of the total displaced metal. It can be expected that area displaced to spread is a function of the bar size and draft. Figure 10 is a typical hypothetical curve such as may be used to determine pass depth and parting for a given set of conditions. It seems that the relationship illustrated by Figure 10 is realistic, since an increase in spread is expected for smaller sections, roll size remaining constant. This is so because of the relatively large contact area of small sections rolled on large rolls and the heavier drafting of the smaller sizes. Once the curve of Figure 10 is established in reasonable proximity of actual conditions, pass depths can be determined with consistent results. As a check against gross errors an experienced eye can guess reasonably close for an approximation. It is suggested that the first move is to estimate the fraction displaced to spread for the smallest and largest size and several intermediate sizes. The balance of the sizes can be extrapolated from the curve. As a typical example, an actual cobble of a leader and finisher of a $\frac{17}{32}$-in. bar rolled on a 9-in. bar mill measured, as follows:

Area of finished bar = 0.26 sq in.
Area of leader = 0.30 sq in.
Area displaced, A_d = 0.08 sq in.
Area displaced to spread, A_s = 0.04 sq in.

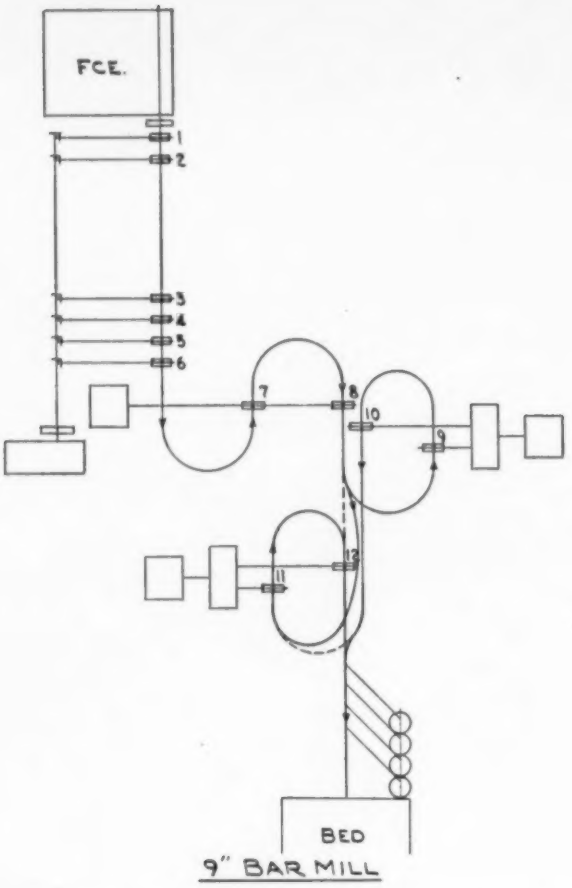
$$\text{Per cent of displaced area to spread} = \frac{A_s}{A_d} \times 100$$

$$= \frac{0.04 \times 100}{0.08} = 50 \text{ per cent}$$

This high percentage indicates heavy drafting.

As a matter of fact, the two pass rolling method used in this case required a heavy draft in order to develop the corners.

Forming and breakdown passes — The forming passes preceding the leader for the method of rolling under consideration differ considerably from mill to mill. It is possible to enter shapes varying from a blunt oval to a six-sided polygon into the leader pass. For the smallest



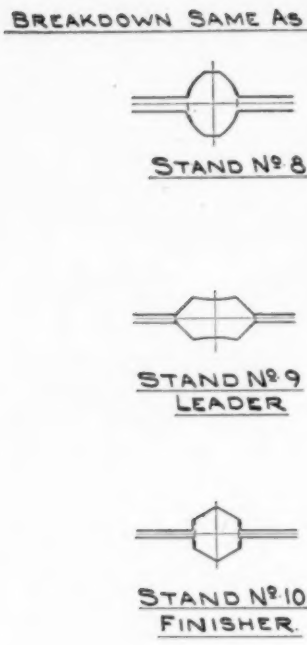


Figure 11 — This 9-in. semi-continuous mill rolls hexagons from the same breakdown passes as rounds in two passes.

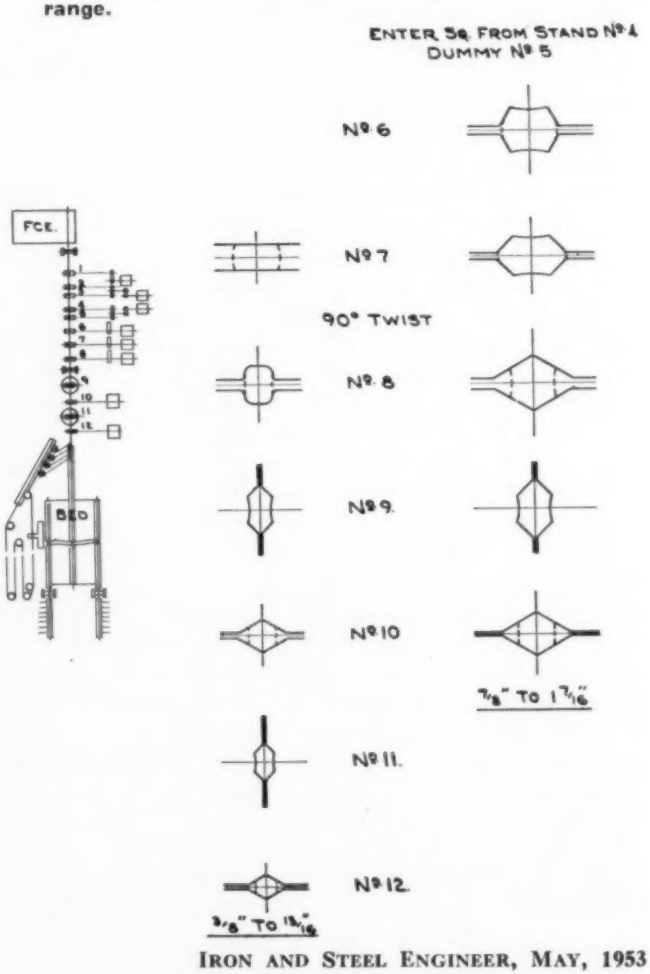
sizes, it is quite common to use an edged oval as a former. The mill of Figure 11, a 9-in. semi-continuous mill rolls hexagons from the same breakdown passes as rounds in but two passes. Because of mill arrangement rounds can be rolled while changing No. 9 stand and No. 10 stand for hexagons and vice versa without a complete cessation of rolling.

The 10-in. continuous bar mill of Figure 12 utilizes two forming passes preceding the leader pass for its small size range, $\frac{3}{8}$ to $\frac{15}{16}$ in. In this instance the breakdown sequence parallels that of rounds, making for flexibility. In the large size range, $\frac{7}{8}$ to $1\frac{7}{16}$ in., three forming passes precede the leader. Except for the first three passes this breakdown has nothing in common with other products.

Figure 13 illustrates a 14-in. cross country mill and corresponding pass layout for a range 1 to $2\frac{5}{16}$ in. Four forming passes precede the leader pass. Passes No. 8 and No. 9 show that the bar is drafted twice in succession without turning. This pass arrangement avoids the use of special equipment or manpower for edging up. It is an example of how a roll pass layout is modified to suit mill peculiarities.

Whether to incorporate more or less special forming passes depends to some extent on the potential accumulated tonnage available for rollings. When small lot individual size hexagon orders are to be rolled, it is advantageous to line up the hexagon passes with round breakdown passes. The ratio of rounds rolled to hexagons rolled by weight on typical merchant mills may vary widely from 1:1 to 10:1. It is obvious that in the latter case an individual roughing set up would not be economical.

Figure 12 — This 10-in. continuous bar mill uses two forming passes ahead of the leader pass in its small size range.



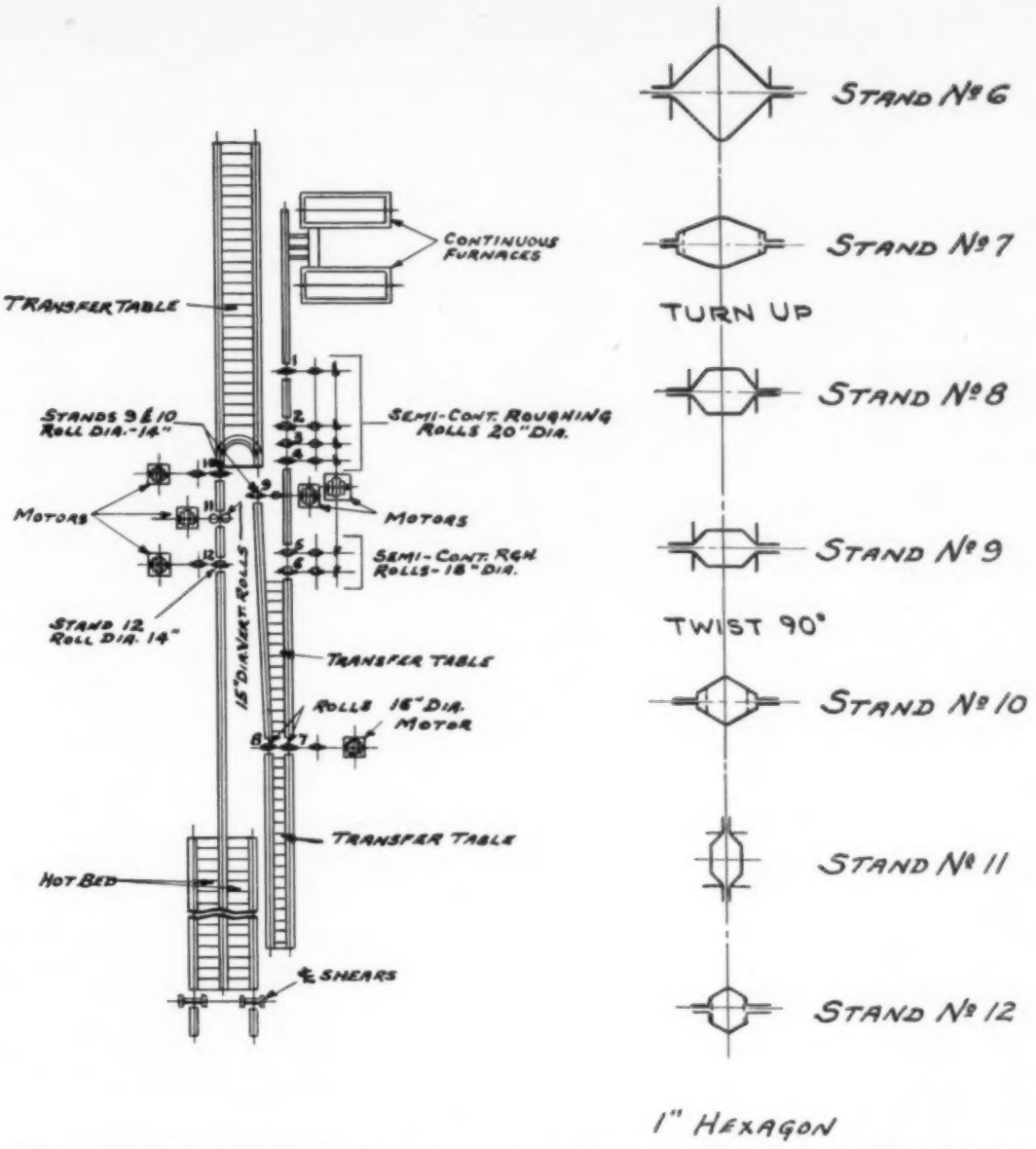
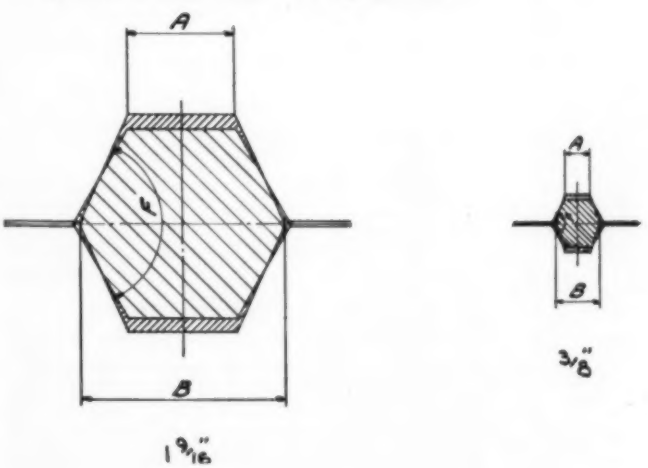


Figure 13 — Illustration shows layout and pass schedule for a 14-in. cross country mill.

PASS DESIGN — FINISHING PASS PARTED AT CORNERS

Finishing pass — For the method of finishing with the parting at the corners, it is not possible to vary the finishing pass design except for the parting which is kept at a practical minimum.

Figure 14 — Sketches of superimposed finisher and leader passes for two sizes of hexagon bars.



The leader pass — Figure 14 shows superimposed finisher and leader passes for a 1 9/16-in. hexagon and a 3/8-in. hexagon bar. It is noticeable that the area displaced to spread is small by comparison to the method discussed previously. This is so because of the confining action of the finishing pass and because the drafting must be moderate. Otherwise, the filling of the open corners would become critical and difficult to control. The small, 3/8-in. bar, shows the larger spreads, as is to be expected.

Essentially there is but one variable to consider in laying out the leader passes for this method of rolling, the angle "F" of Figure 15. Indirectly, this angle fixes the draft. The dimension "B" is maintained less than the diagonal of the hexagon to allow for spread while dimension "A" should be slightly less than the flat of the hexagon. Using data obtained from the pass designs of two representative bar mills the variation of angle "F" is found to range between 131 to 142 degrees. A 10-in. continuous bar mill designated, "E," uses a constant angle "F" for the full range. Another 10-in. continuous

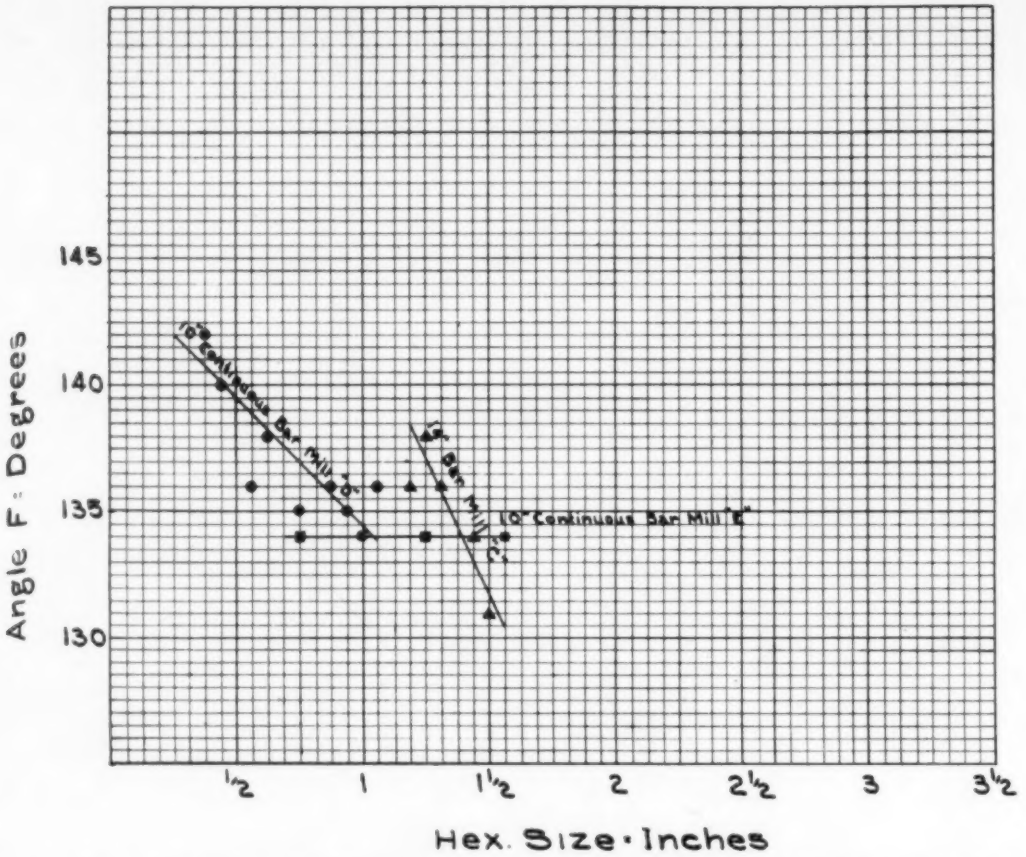


Figure 15 — Curve gives apex angle of leader for various bar sizes in method using finishing pass parted at corners.

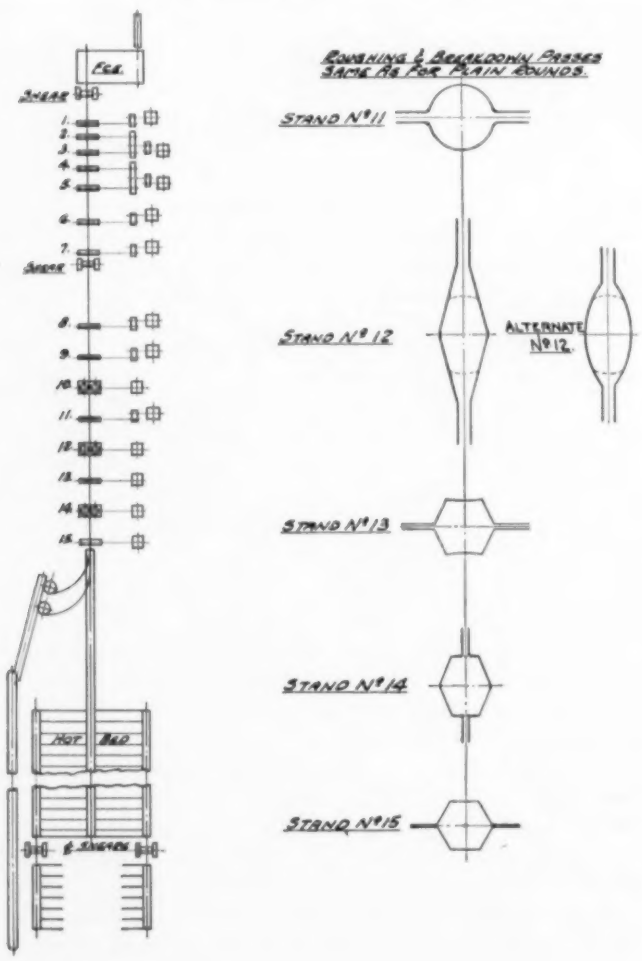
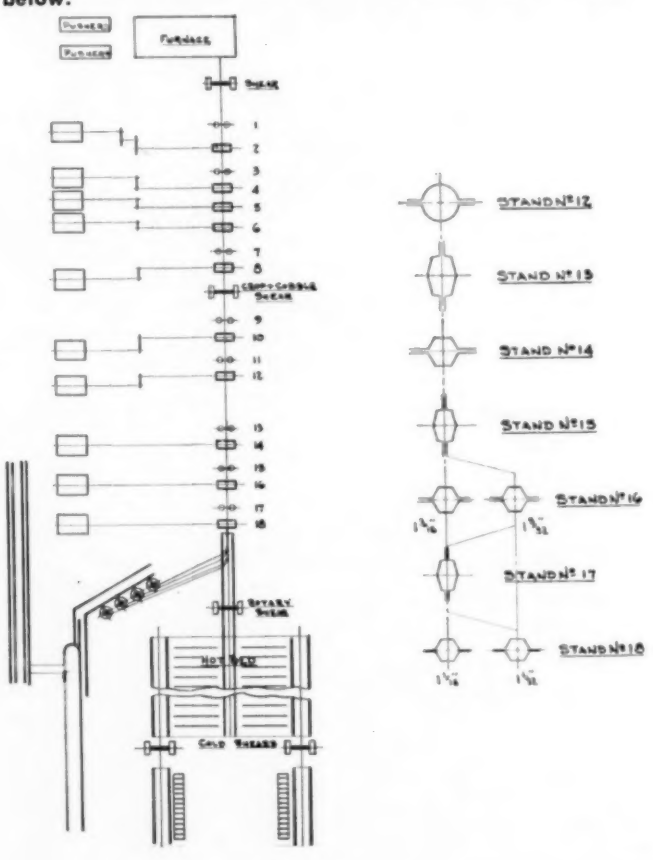


Figure 16 — The roll pass schedule at left uses the same roughing and break-down passes for the rounds as for the hexagons up through stand No. 11.

Figure 17 — Another pass schedule is given in the layout below.



bar mill, "D," shows the normal tendency to reduce draft with an increase in bar size.

Corner formation at the roll parting is rather sensitive. The apex of the leader pass must be filled and must flow equally into opposite corners at the finishing roll parting.

When the leader pass is in vertical edgers, it is advisable to design the pass with 5 degree collars intersecting the points to which the pass is theoretically filled. This is for the purpose of regulating and centralizing the stock and lining up the passes.

Forming and breakdown passes — At least one forming pass, resembling the finishing pass is used before the leader pass. It is possible to enter an oval into this pass. However, corners will be formed more successfully by the addition of one or more diamond type passes.

A typical pass layout, Figure 16, illustrates a layout which ties in with the round breakdown passes at stand No. 11. Roll changes are required for four sets if hexagons are scheduled with rounds. Another somewhat similar layout is depicted by Figure 17. One additional forming pass is used so that two or more sizes can be rolled with each set-up. Passes 15 and 17 are both leaders while 16 and 18 are both finishers. By this arrangement a minimum of roll changes and move overs are required in order to roll several sizes.

SUMMARY

In dealing with a topic as confined and specialized as this, it is possible to take the attitude that the subject matter is trivial. The task of designing passes for hexagons is of such simplicity that it lends itself to procedures similar to those outlined as contrasted to the singularity of shape pass design. The scattering of the points of the curves and the various curve slopes indicate that there are many viewpoints as to proportions in design. Whatever they are, consistency should make for better results.

The stepped up delivery speeds and production rates of the modern bar mill will require not only refinements in design but flexibility for size changes. Time for changing passes and rolls is at a greater premium, the higher the production rate, because of the greater frequency of changes. The obvious answer has been to accumulate larger tonnages for rollings. Unfortunately this is not always possible in the case of hexagon bars, particularly for the smaller producers.

The problem of quality and quantity of production involves the roll designer even more than heretofore. Even on such simple items as this, obviously lacking the complexity that delights designers, there is work ahead on new mills and the older ones.

DISCUSSION

PRESENTED BY

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H. E. MULLER, Assistant Superintendent, Roll Department, Inland Steel Co., Indiana Harbor, Ind.

F. G. KREDEL, Superintendent, Republic Steel Corp., Cleveland, Ohio.

W. H. MOHLER, Superintendent Roll Shop, United States Steel Corp., McDonald, Ohio.

JAMES J. O'BRIEN, Works Manager, Steel Division, Firth-Sterling, Pittsburgh, Pa.

C. S. LAMBERT, Superintendent, Youngstown Sheet & Tube Co., Youngstown, Ohio.

H. A. CARTER, Superintendent Roll Department, Bethlehem Steel Co., Lackawanna, N. Y.

GILBERT G. GALAMBUS, Superintendent Roll Department, Youngstown Sheet & Tube Co., East Chicago, Ind.

J. B. BENNETT, Metallurgist, Bethlehem Steel Co., Johnstown, Pa.

A. M. Cameron: Most of the hexagons discussed were sulphurized steels and required an additional processing of cold drawing for automatic machine work. However, we in the alloy and tool steel business are asked to supply hexagons particularly in stainless grades where the customer is reluctant to pay the added price for cold drawing to get a close tolerance, and we are at the point where we are asked to supply hexagons up to 1¼ in., with a tolerance of ± 0.005 in. I wonder if Mr. Muller would give us his opinion of how he would produce a bar to these tolerances.

H. E. Muller: Our mills roll hexagons to standard published tolerances only. Tolerances of plus or minus 0.005 in. are closer than standard hot rolled tolerances but not as close as cold drawn tolerances. I do not think we would entertain the thought of rolling to plus or minus 0.005 in. I believe that some mills have attempted this, however. Supplementary idler rolls have been positioned on the delivery side of the finishing pass for the purpose of truing up the section. To anyone attempting the hot rolling of close tolerance hexagons, I would recommend the method of parting at the corners.

F. G. Kredel: Any discussion I would get into on hexagons, would be with open hearth and sulphur grades, including bessemer. Present day bar mill operations tend toward simplicity, less delays, rapid roll changing, and in the end a better finished bar product.

Republic Steel centers most of its hexagon rolling at Youngstown, but Cleveland, due to the fact that it has coiling facilities, rolls sizes ⅞ in. and down. At Cleveland we roll this range from a round former, or a round edger, in two passes. The finishing passes are parted at the sides, and the holes are tight, or snug holes.

I would like to ask Mr. Muller if he thinks it possible to go beyond ⅞-in. hexagon, finishing in two passes, and using a round edger or round former ahead of the leader pass?

H. E. Muller: I would not consider it advisable to use the two pass method of rolling hexagons for sizes larger than ⅞ in. This method requires larger drafts in the leader and finishing passes in order to insure sharp corners. This in turn would make it more difficult to control the formation of the open sides in the finishing pass, especially in view of the greater concavity required in the leader pass.

W. H. Mohler: There are several methods of finishing hexagons. Some mills use the open corner method and others the open side method.

The principal advantage of the open side method is that the appearance of the finished bar is good regardless to the slight changes in cross-sectional area that originates from the variations in temperature throughout the billet length. In addition, several sizes may be rolled on the same finishing pass, thereby reducing down-time on the mill and roll turning in the shop.

The open corner method assures positive angularity of the sides, but the corners become susceptible to any slight variation in temperature or mill condition and may show a pinch or an under-fill.

Would Mr. Muller state if he possesses any statistics that he could give, showing the advantage of one method over the other relating to production in rolling this type of product on the various continuous mills he indicated.

H. E. Muller: I have no statistics showing the advantage of rolling hexagons by either method. Of three continuous bar mills, two roll by method of parting at the corners and one by method of parting at the flats. I would like to ask Mr. J. O'Brien what his views are on this subject in the light of his experience.

James T. O'Brien: As I recall, about 20 per cent of the production of the twelve-stand continuous bar mill at McDonald was hexagons. Since the production on this mill varied from 20,000 to 28,000 tons per month, rollings from 4000 to 9000 tons in a large size range from $\frac{3}{8}$ to $1\frac{5}{16}$ in. were common. All except a very small percent were produced by the method described by the author as the open face method, i.e., the opening in the finishing roll was at the center of two of the faces. We were definitely prejudiced against the open corner method since we felt that we lost ten additional minutes in starting the sizes by this method as compared to the open face design. Since we made many sizes in each rolling, this amounted to too much lost time. The number of rolls necessary to maintain all the sizes was also greater on the open corner method. I would say that the quality of the open-cornered material as compared to that which is finished with the opening on the face, is essentially the same except that on the material that was rolled with the open corners, the faces are likely to be a little more accurate as far as uniformity is concerned.

C. S. Lambert: Mr. Muller is to be congratulated on a very fine presentation of a highly controversial subject which has been of concern to operators for many years. In my experience I have found that the method of parting on the flat has proven to be the best as pass life is greater, thereby requiring less roll changes and greater productivity. In reference to Figure 11 you do not show a radius on the breaking corner which we have used with good results as marking and lapping have been eliminated. One question I would like to ask is what do you recommend in the way of the design of the leader pass in a looping mill such as shown in Figure 11?

H. E. Muller: Mr. Lambert is correct in his observation that corner radii should be put on the edges of the leader pass. This is essential because often times the roller attempts to overfill the leader pass very slightly in order to insure formation of sharp top and bottom corners in the finishing pass. If the corners on the leader pass were not broken, a lap might appear at this position on the finished bar. To my knowledge, most shops turn a radius of at least $\frac{1}{32}$ in. on these corners.

The leader pass shown on Figure 11 is looped through a mechanical repeater into the finishing pass. One reason for the greater width of this pass is to permit greater control of the bar by the twist delivery guides which turn the bar into the repeater.

H. A. Carter: I agree with what Mr. Muller has written in its entirety. We have made hexagons to both designs of parting the finishing passes at corners and at flats, but on our high speed continuous mill we have found the parting at the corners much more desirable.

Mill men favor this method because it is so much simpler to get section and hold section. The roller can tell at once if rolls are crossed, and definitely, bars can be held to closer tolerance. We do, however, get occasional overfills at the corners which require some secondary labor cost.

The passes shown on Figure 16 of Mr. Muller's paper are excellent and the No. 12 stand, diamond vertical pass is certainly an improvement to the closed pass. This enables a mill to use same forming pass for a whole range of sizes by simply opening or closing rolls.

H. E. Muller: It is interesting to note that the mill men of your organization prefer the method of finishing on the corners. Our own people have the same preference. It seems that this question will remain controversial.

Gilbert G. Galambus: I notice in the finishing pass you mention that you cover various sizes. I would like to ask what sizes are covered in the leader. I notice you use roller guides in the leader, do you use any roller guides anywhere else in the mill when rolling hexagons?

H. E. Muller: The leader pass will cover a range of from $^1/_{52}$ to $\frac{1}{16}$ in. For the smaller sizes, $\frac{1}{32}$-in. increments are used, for the larger sizes $\frac{1}{16}$ in. steps.

Roller guides may be used on the entry side of the forming pass preceding the leader pass. I have in mind at least one mill that does this.

J. B. Bennett: It is our opinion that the open side method of open steels concentrates surface defects on those open sides. Our question to Mr. Muller is: "What has been your experience with the effect on surface quality of these two methods of rolling hexagons?"

H. E. Muller: The method of parting the finishing pass at the flats should have no adverse effect on surface quality. The open faces will show a different texture than the rolled-on sides. The method of parting on the corners may at times produce slight overfills at the open corners. I have not found other surface defects in my experience which could be attributed to the method of finishing. It seems to me that surface defects other than mechanical due to guides, etc. must originate in earlier stages.

THE MAGNETIC AMPLIFIER AND ITS APPLICATION IN THE STEEL INDUSTRY

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. . . . the magnetic amplifier has proved to be a dependable and effective tool in regulating systems . . . .

▲ THE application of magnetic amplifiers in the iron and steel industry has been speeded by the tremendous recent progress in the art of regulating system design. The story of the amplistat, a form of self-saturating, static, magnetic amplifier for regulating circuits was presented to the Association of Iron and Steel Engineers three years ago. See "A Static Magnetic Amplifier for Regulating Circuits," by H. E. Larson and T. Dunnegan, Jr., Proceedings AISE 1950, p 405. The original development installations reported at that time are still in service. Many more equipments have been installed, and more has been learned both through experience and analysis of the possibilities and limitations of the magnetic amplifier. A brief review of the principles of operation and application of this form of regulating equipment as well as a look at the future possibilities is now in order.

BASIC CONCEPTS

The amplistat combines a saturable core reactor and a rectifier in a self-saturating magnetic amplifier circuit. The reactor somewhat resembles a transformer with several windings linking one or more laminated iron cores. However, it differs from the transformer in that the core is designed to be operated in the region of magnetic saturation during part of each cycle. Selenium and germanium metallic rectifiers are most commonly used with the reactors. The output current of this combination which flows through the output winding of the reactor has a d-c component and produces the bulk of the magnetizing force on the core of the reactor. The magnetizing force furnished by the d-c control winding or windings is usually only a small fraction of that furnished by the output winding, but holds the "balance of power" in saturating the core. When the core saturates, the impedance of the output winding and the a-c voltage induced in the output winding are practically eliminated, permitting a large direct current to flow to control the operation of the system.

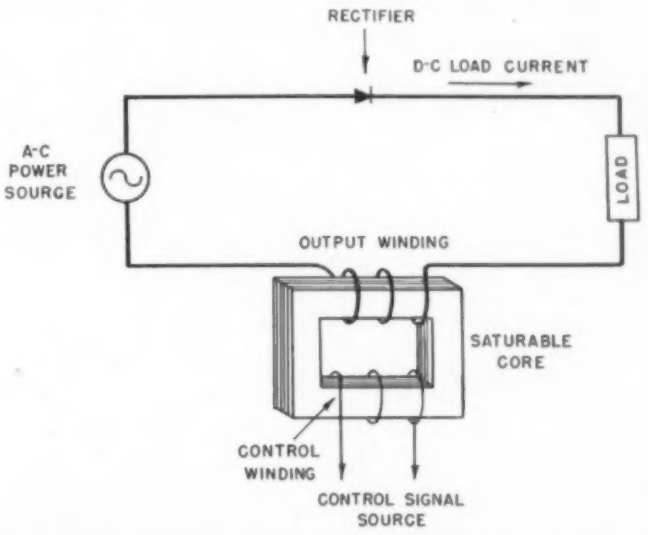


Figure 1 — Circuit shows elementary, self-saturated magnetic amplifier.

Saturable core reactors have been used by themselves for power control devices for many years. However, their use has been restricted by their slow response and low amplification. The amplistat is very much improved

in both characteristics and has found wide application in regulating systems.

The circuit of an elementary, self-saturated magnetic amplifier is shown in Figure 1. While this particular circuit has little practical value because of an objectional high voltage induced in the control winding, its simplicity is helpful in gaining an understanding of the operation of more practical forms of the magnetic amplifier.

Reference to Figure 2 is also necessary to understand the part that saturation of the reactor core plays in the operation of a magnetic amplifier. In normal amplistat design, the relation between the rate of increase of the

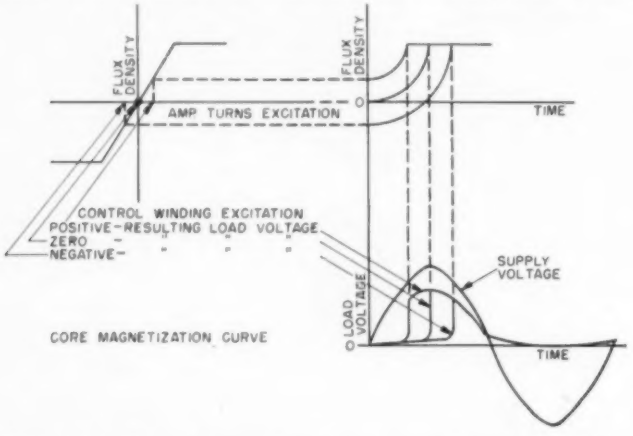


Figure 2 — Core magnetization curve shows effects on flux density and load voltage for various control winding excitations.

a-c supply voltage and the rate of increase of flux density in the core is made such that saturation is reached at approximately the positive peak of the supply voltage with no applied signal.

With zero signal applied to the control winding, the core saturates during the first half cycle of the impressed a-c voltage. However, before this point is reached, there is a voltage induced in the output winding of the reactor which opposes the flow of current. Also, the impedance of this winding is relatively large. When the core saturates, the flux no longer changes and there is no voltage induced in the output winding of the reactor. The impedance of the output winding drops to its resistance value and a large current flows through the rectifier and the load, super-saturating the core.

When a positive signal is impressed upon the control winding so that the core is partially excited by this winding, the reactor core saturates sooner than with no excitation from the control winding. Thus, a large current flows through the rectifier and the load for a greater portion of the positive half of the a-c voltage cycle.

When a negative signal is applied to the control winding, opposing the load circuit ampere turns, the core saturates later than with zero signal to the control winding. Figure 2 shows that the core actually saturates after the peak value of the a-c supply voltage is reached. The explanation for this phenomenon is that, as in any highly inductive circuit, the magnetizing current and the flux it produces lags the applied a-c voltage by almost 90 electrical degrees. Therefore, the magnetizing current continues to increase, even as the applied voltage decreases. The magnetizing current retains the saturation values after the voltage peak has been reached. Therefore, with a negative signal the rectifier passes a large current through the load for a smaller portion of the positive half of the a-c voltage cycle than when zero or a positive value of d-c signal voltage is applied to the control winding.

The magnitude of the negative signal impressed on the control winding can be increased to the point where the core will never saturate, and the amplistat conducts only a very small current through the load.

The variation of d-c signal input results in control of the firing point between zero and 180 degrees of the supply cycle. The input power to the d-c control winding is very small compared to the load current so considerable amplification can be realized. As can be seen, the operation of this simple magnetic amplifier is quite similar to the operation of a grid controlled thyratron.

In reality, the core of magnetization curve as shown in Figure 2 does not have zero slope above saturation. Also, the forward rectifier resistance is not linear. With these factors considered, the load current wave form of an actual amplistat might be as shown in Figure 3 for the three different firing points. Normally, the control of the firing point over the last 120 degrees of the supply cycle can be achieved.

It should be noted that magnetic amplifiers perform as current amplifiers while rotating amplifiers act as voltage amplifiers. The magnetic amplifier has the irreversible characteristics of the rectifiers while the rotating amplifier is inherently reversible. For reversing applications, either two generator fields and two magnetic amplifiers must be used, or efficiency must be sacrificed in two magnetic amplifier units to convert them from current amplifiers to a reversing voltage amplifier. In either case, two sets of reactors and rectifiers are required. In the first case, more copper is required on the pole pieces of the generator, possibly

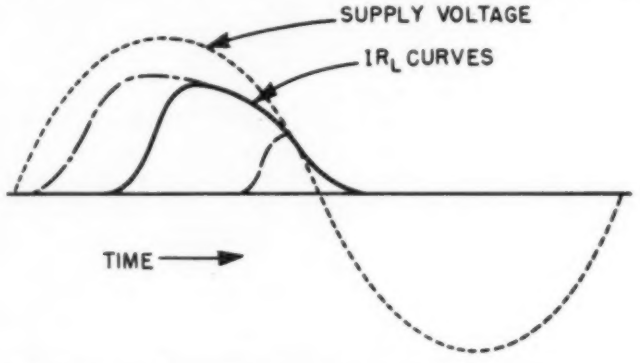


Figure 3 — Current wave shapes for actual amplistat.

meaning a larger generator. In the second case, larger magnetic amplifier units with a continuous power loss are required. With inductance loads, the efficiency of a reversing magnetic amplifier can be even less than 20 per cent.

The fact that the output or load current of the magnetic amplifier is of pulsating nature must also be considered. It is the average value of the output current that is important in determining the average flux excitation in a generator, rotating regulator, or another reactor, while it is the root mean square value that determines the heating in the excited winding.

CHARACTERISTICS

The steady state input-output characteristics of the magnetic amplifier are shown in Figure 4. This curve is seen to be somewhat similar to the saturation curve of a d-c generator except that the output does not reverse when the control signal is reversed. The normal operating range of the magnetic amplifier is selected to be that portion of the characteristic through which

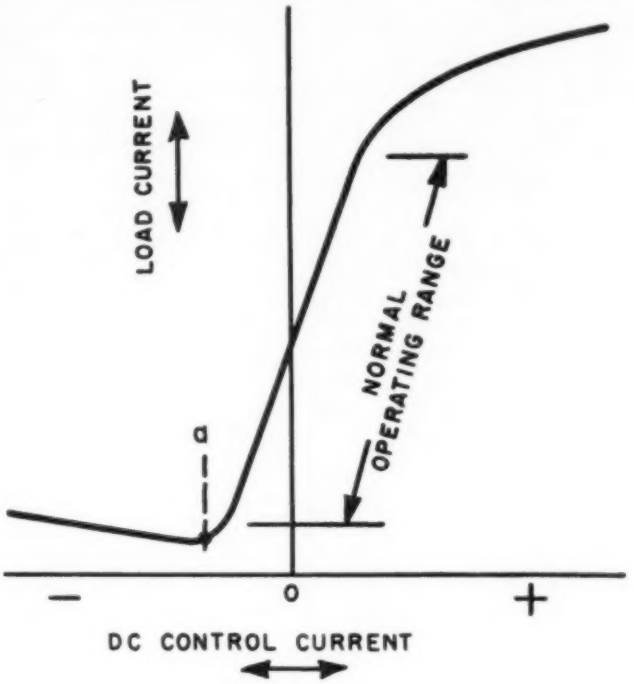


Figure 4 — Amplification curve for amplistat

the output current varies almost linearly with changes in control signals. The amplification factor, or gain, of the magnetic amplifier is given by the slope of input-output curve. Since the magnetic amplifier is a self-saturating, or self-excited device, considerable output is obtained with zero control excitation. Negative excitation, or bias winding, is required to reduce the output to its minimum value.

It should be noted that if large values of reverse excitation are applied, the output current again begins to increase in the opposite direction. This results from the fact that the core has been pre-magnetized past the lower knee of the core magnetization curve shown in Figure 2, and is, therefore, saturated at the start of the operating half cycle. The load current starts to build up under this saturated condition but its resulting MMF is in the opposite direction to the MMF set up by the signal current. Therefore, the load current drives the core back into the unsaturated region and the load current is reduced. This increase in output with an increasing negative control signal could be most disconcerting in a closed loop regulating system. However, techniques have been developed for avoiding this difficulty and just recently, new circuits have been developed which reduce the load current to practically zero at the point (a) and eliminate the build-up of load current with high negative control signals. During transient conditions, the magnetic amplifier may be forced into its non-linear output region to provide maximum forcing as required by the regulating system.

In a magnetic amplifier, as well as in any control element, there will be a time delay between the application of the input signal and the response of the output current to this change. The time constant of the magnetic amplifier is generally defined as the time required for the load current to build up to 63 per cent of its final average value in response to a step function change of control voltage. Since the output current of the magnetic amplifier is affected by the characteristics of the load, this definition of time constant requires a pure resistance load. The time constant of the magnetic amplifier can be controlled by the selection of the control windings as well as by the use of external resistance. At the expense of overall amplification, the time constant can be made very short approaching the theoretical limit of one half cycle of the a-c impressed voltage. Since the output current appears as pulses occurring once each cycle, obviously a change in the average output current cannot be observed until the next pulse appears after the signal is applied to the control winding. Since the time constant is very definitely a function of the supply frequency, performance can be improved by increasing the frequency to 400 or even 1000 cycles.

Figure 5 — Typical input-output characteristic of amplistat shows relation between average load current and control winding excitation for various values of applied a-c voltage.

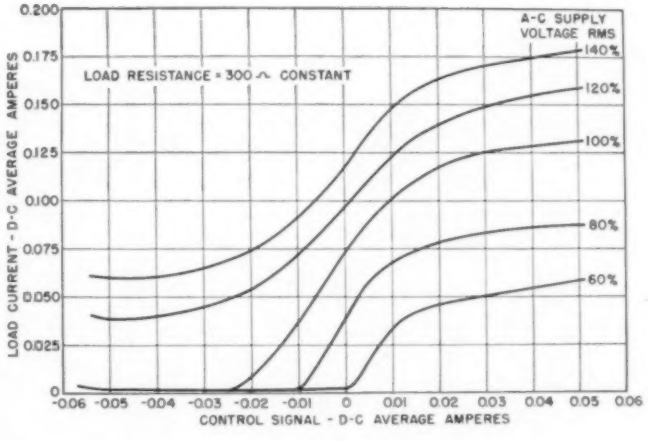
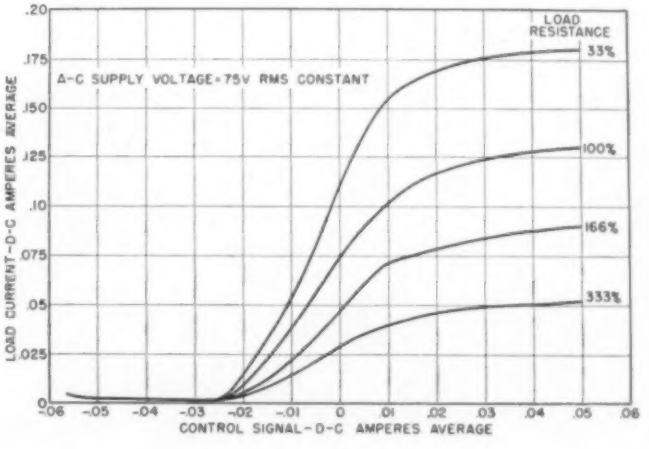


Figure 6 — Typical input-output characteristics of an amplistat shows relation between average load current and control winding excitation for various values of load resistance.



The characteristics of the magnetic amplifier are affected by variations in a-c voltage and frequency. With more than 100 per cent voltage applied, the minimum possible output current is increased, as well as the maximum output current. With less than 100 per cent voltage, the maximum output current is decreased as well as the range of operation. For a given value of applied voltage, the effect of a decrease in frequency of power supply is similar to an increase in the applied voltage and vice versa. Constant voltage transformers should be used to minimize the effect of a-c voltage fluctuations. Frequency variations are seldom of enough magnitude to cause concern.

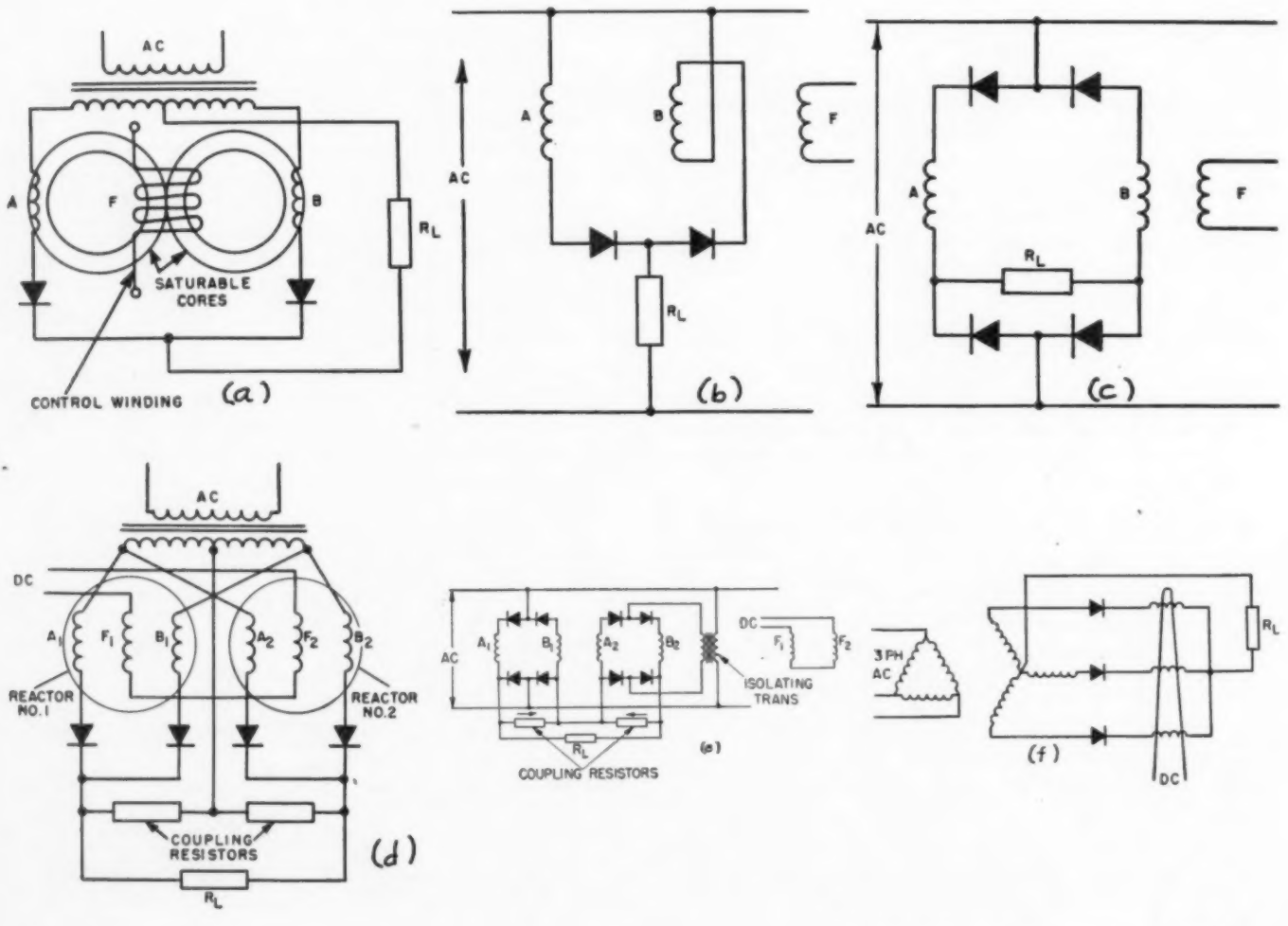
Before the core of the magnetic amplifier reactor saturates, the effect of the load resistance in limiting the small load currents that normally flow is negligible compared to the impedance effect of the output winding. After the core saturates, the load resistance becomes the predominating factor in limiting the load current. The optimum load resistance is that which results in the greatest volt-ampere transfer to the load for a given signal change.

Obviously decreasing the load resistance increases the amplification factor. However, since it is achieved by increasing the maximum load current, such adjustments should be made with caution lest the rated temperature rise of the equipment be exceeded.

BASIC CIRCUITS

Several basic, yet practical, amplistat circuits are shown in Figure 7. The center tap circuit shown in Figure 7a is one of the most used amplistat circuits and is very easily understood by following the basic theory previously presented. This amplistat consists of a center tapped power transformer; two saturable reactors, each with its own a-c winding; and two rectifiers, one in series with each a-c winding. Each rectifier is connected to the load, which in turn is connected to the center tap of the power transformer. The d-c control winding links both saturable cores. The rectifiers permit only a unidirectional current flow in the a-c windings, and each core controls the load current on alternate half cycles. At the start of either supply voltage half cycle, there will be no current flowing in the a-c control winding. As the voltage builds up in a positive direction, current will begin to flow through the rectifier into the load. This current is limited to a very small value by the large inductance of the winding, which continues to be large as long as the core is unsaturated. When the core becomes saturated, the inductance falls and the a-c winding no longer limits the current in the load circuit. The current will quickly increase to a value limited by the load circuit resistance. By varying the current through the control winding, the firing point of the

Figure 7 — Basic amplistat circuits are shown for the following six cases: a. center tap amplistat; b. a-c amplistat; c. bridge amplistat; d. push-pull center tap amplistat; e. push-pull bridge amplistat; and f. three phase Y amplistat.



amplistat and therefore the average load current can be controlled.

The bridge amplistat, Figure 7c, is similar in operation to the center tap amplistat and substitutes two more rectifiers in the place of the center tapped supply transformer. However, this is no advantage unless the amplistat and its associated load circuit can be designed to operate on a-c line voltage.

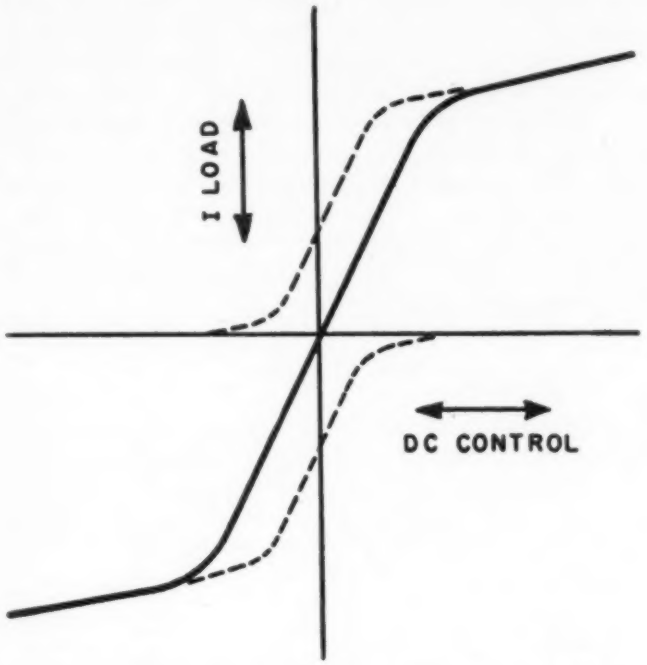
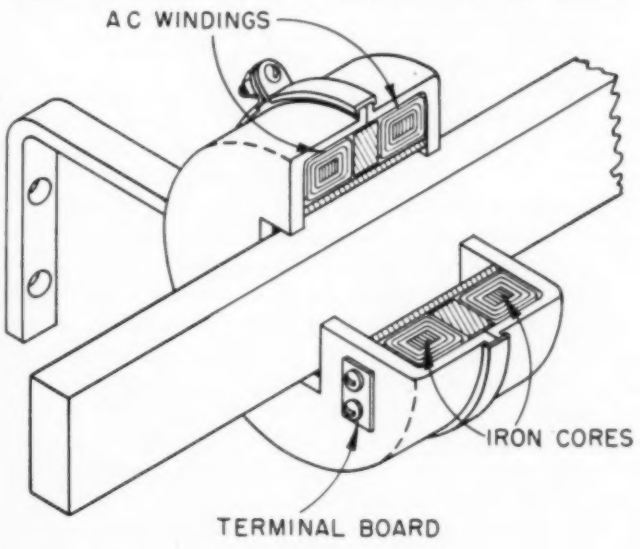


Figure 8 — Amplification curve for push-pull amplistat.

The push-pull center tap, Figure 7d, and the push-pull bridge, Figure 7e, operate exactly as described above for the single ended circuits. The amplification curve, Figure 8, for the push-pull circuits is merely a composite of two characteristics of the type previously shown in Figure 4. Push-pull circuits at present are most commonly used for small signal, low output applications for reasons given earlier. The coupling resistor shown in the two circuits will dissipate several times more power than is usually realized in the load.

Figure 9 — Cutaway view of current measuring reactor.



Most amplistats have been built for relatively low power applications and as such have used single phase power supplies. However, three phase circuits have been developed. Figure 7f shows the three phase wye circuits.

CURRENT MEASURING REACTORS

While actually not an amplistat, the current measuring reactor (CMR) is closely akin to amplistats in theory. This device has sometimes been called a d-c current transformer since this describes its appearance and operating function.

The cutaway view (Figure 9) shows the physical simplicity of the unit. The CMR is not connected into the power circuit, but merely slips over the d-c conductor. The instrument circuit, or control circuit, is isolated from the main circuit, and, therefore, instrument circuit faults have no effect on the main power circuit. It is not necessary to calibrate the leads in the instrument or control circuit, and additional instruments can be added as desired. In addition, the device has practically no time delay and has given outstanding performance when used as the current signal source in current regulating systems.

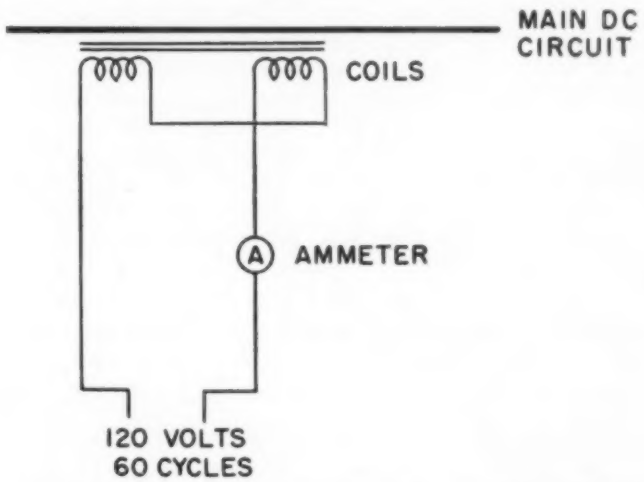


Figure 10 — Schematic diagram of current measuring reactor which read d-c amperes.

The simplicity is further indicated by the circuit shown in Figure 10. Though several circuits are possible, this is the most practical and will serve to illustrate the theory of the operation. Although two coils in series are used, they act independently, and the action of one coil at a time can be observed. The reactor coils are both saturated by the direct current until the a-c voltage is applied. The a-c voltage desaturates the core of one coil on one half-cycle, and the other core on the other half-cycle. The point on the a-c voltage wave where desaturation occurs fixes the ammeter indication, and, in turn, is determined by the initial d-c saturation.

The B-H or excitation curve of the core material (Figure 11) has the sharp knee, with square loop characteristic also found in magnetic amplifiers. The core is saturated by a low value of direct current in the circuit to be measured. For the purposes of illustration, assume that the bus current produces a magnetizing force h_1 and a corresponding flux density b_1. The

60-cycle voltage applied to the circuit superimposes an alternating flux. One half of the applied a-c voltage wave tends to carry the core further into saturation. On this half of the cycle, the saturated reactance of the coil is very low, and the current tends to rise to a fairly high value, following a sine wave.

The other half of the applied a-c voltage wave is in the direction that reduces the flux in the core. Traveling

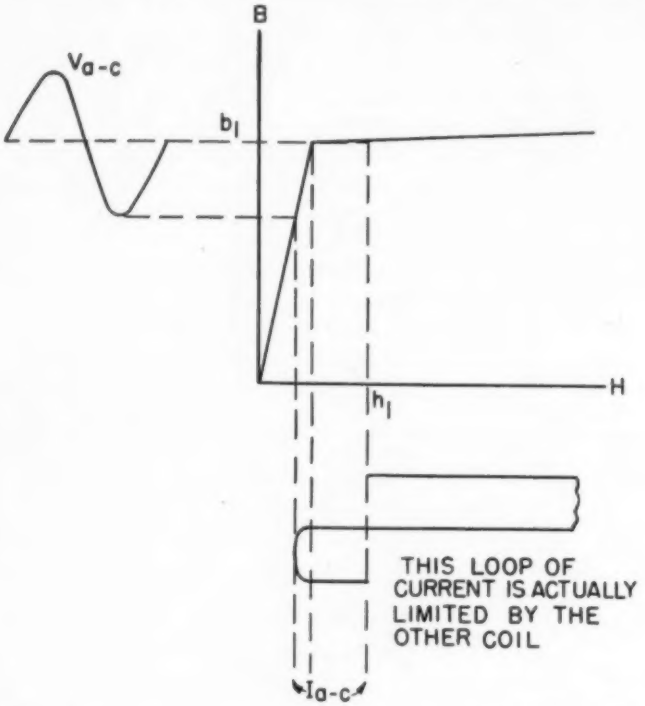


Figure 11 — Curves illustrate how each coil of CMR limits the current in one half of the a-c current wave.

the B-H curve from b_1, it can be seen that, until reaching the sharp knee, the current will still be limited by only the saturated reactance. But as soon as the core becomes unsaturated, the coil's reactance becomes very high, limiting the current. If the direct current being measured had been greater, producing a higher value of flux bias, the a-c current wave would have risen to a higher value before being limited by the unsaturated reactance

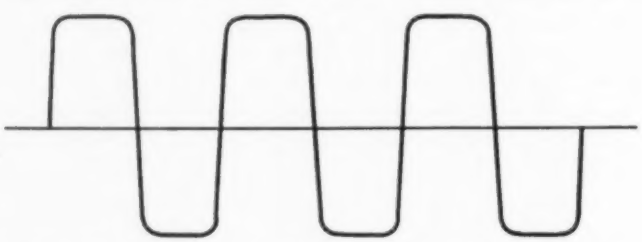


Figure 12 — Wave form of current in the instrument circuit of Figure 10.

of the coil. In this way, each coil clips one half of the current wave, producing an area in that half, closely proportional to the primary direct current.

The second coil is connected so that the superimposed alternating flux causes unsaturation during the opposite half of each cycle. It acts just as described above, but on the other side of the current wave.

Thus, the a-c current never had a chance to rise to the value of current limited only by saturated reactance. Each half of the current wave is clipped, forming an alternating wave that is almost flat-topped as shown in Figure 12. This square wave of current is measured by an a-c ammeter, calibrated to read directly in d-c amperes.

A point worth noting in this circuit is that it cannot determine the direction of current flow in the primary bus. For most applications, this is not important, and the current can flow in only one predetermined direction. Reverse current relaying is usually present to act on an abnormal reversal of direction.

The CMR may be used to obtain a signal for use in a regulating circuit. In such cases, a full wave rectifier may be substituted for the a-c ammeter, and a d-c signal obtained for use in the regulating circuit. Even when an inductive circuit is connected across the rectifier, the d-c current is practically in phase with the current flowing in the main d-c bus.

APPLICATIONS

Magnetic amplifiers have been used in a wide variety of installations in the steel industry. However, before considering an actual installation, it will be helpful to look at a simple application circuit. Figure 13 shows a simple d-c voltage regulator. It can be seen that if a

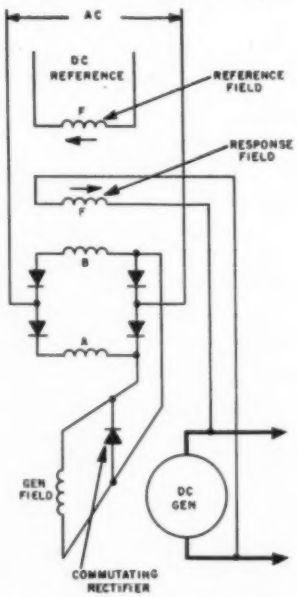


Figure 13 — Schematic diagram shows simple amplistat voltage regulating system.

line dropping resistor or a current measuring reactor is substituted for the generator voltage feedback, a current regulating system is obtained. Also, the substitution of a tachometer signal for the generator voltage feedback gives a speed regulator. Combinations of these circuits can be used to obtain a generator voltage control with IR compensation, current limit, voltage limit, etc.

Magnetic loop control — Possibly the most outstanding and widely known application of amplistats in the steel industry is that of the magnetic loop control in acid tanks on continuous pickling lines. This magnetic loop control was developed to fill the need for a faster, more dependable, easily maintained control for loop position in pickling tanks. Its design simplifies the pickling operation.

This system makes possible faster correction of devia-

tions from proper loop position and assures more uniform pickling results. The old-fashioned dancer roll is eliminated, thereby decreasing maintenance.

A schematic diagram of the magnetic loop control system for steel mill pickling lines is shown in the Figure 14. An acid-proof magnetic pick-up rests in the bottom of the tank. It keeps the strip near the tank bottom for maximum pickling efficiency but does not allow the strip to scrape the bottom of the tank. Output of the pick-up unit is amplified through an amplistat and rotating regulator to control a buck-boost generator in series with the armature of the pinch roll drive motor. This system controls the speed of the pinch rolls to regulate the position of the strip loop.

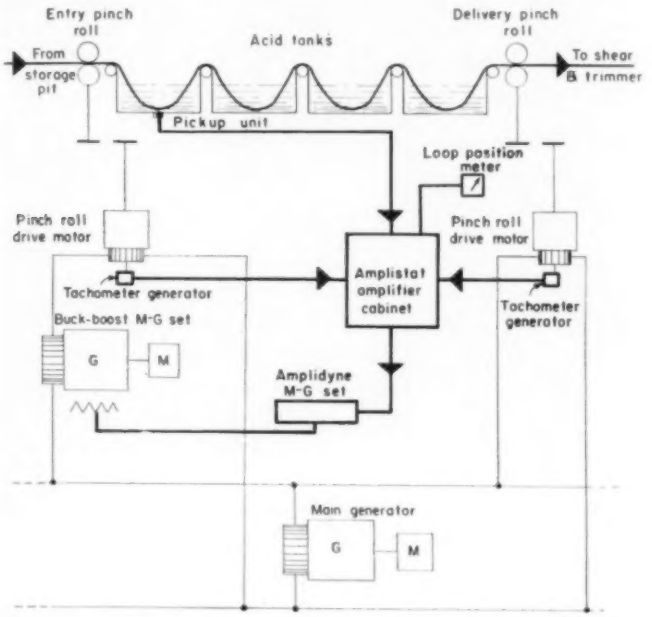


Figure 14 — Schematic diagram of magnetic loop control system for steel mill pickling lines.

The magnetic pick-up device and the amplistat unit are shown in Figures 15 and 16. The magnetic pick-up unit consists of a long, closed, two-legged magnetic column on which are wound three separate windings. One winding on each leg is excited with alternating current. The third winding encloses both legs and is excited with direct current. Most of the d-c flux is leakage flux and therefore greatly influenced by the proximity of magnetic material such as the steel strip. The degree of saturation of the iron core depends upon the proximity of the steel strip. The impedance of the a-c coils depends upon the saturation of the core. Hence, the current in a-c coil is proportional to the proximity of the steel strip to the pick-up unit. The pick-up unit thus converts flux to an electrical signal proportional to the loop height and sends the signal to the amplistat.

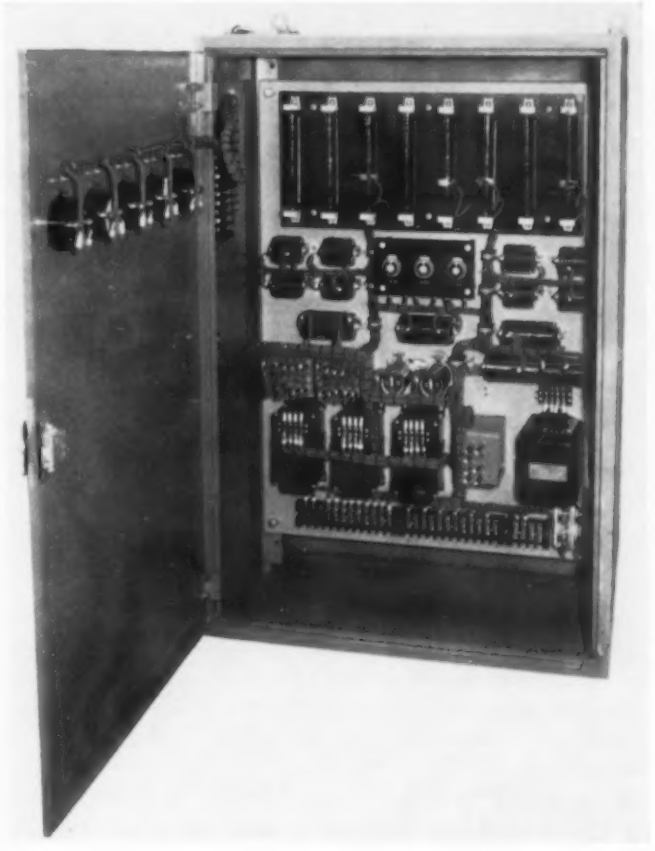
The core and coil assembly of the pick-up unit is impregnated with a thermal setting plastic insulation and encased in a lead cylinder. The leads are brought out through a lead pipe and the entire assembly is covered with alternate layers of plastic tape and glass tape which are baked in position for additional protection against acid corrosion. Several of these fixed units have been operating in pickling acid for over three years. They show no signs of corrosion and no changes in sensitivity or operating characteristics.

Figure 15 — Acid-proof pick-up unit for magnetic loop control.

In the amplistat (Figure 16), the loop position signal of the pick-up unit is compared electrically with a voltage reference. The reference is set during initial installation adjustment and usually no further change is necessary. The reference determines the normal position in which the control will hold the steel strip. The difference signal is amplified by the amplistat and the output fed into the rotating regulator. The amplistat is a two-stage unit. The first-stage is a push-pull center tap unit similar to that shown in Figure 7c, except that the coupling resistors have been replaced by two windings of the second-stage amplistat. The second-stage unit is also a center tap amplistat and is similar to the one shown in Figure 7a.

The magnetic loop control is a position regulator. One of the most effective ways to stabilize such a regulating system is to use a signal proportional to the rate of change of the quantity being regulated. For this system, this quantity is the derivative of position or strip speed. Tachometer generators are used at each end of the tank. The two voltages are compared and the resultant rela-

Figure 16 — Amplistat for magnetic loop control system.



tive speed signal tells the amplifier whether the strip is moving up or down. When the relative speed signal is zero, the loop height is not changing. When the pick-up unit signal is normal, the amplistat uses the tachometer signal to hold the entry pinch roll speed in synchronism with the delivery end roll. Thus accurate synchronization of pinch roll speed tends to hold strip loop at normal height regardless of strip speed. The pick-up unit detects and causes the control to correct any tendency of the loop to drift up or down.

The pickling line operator does not have to make any adjustments or even be concerned about loop height control. It is all automatic. The loop position meter is usually mounted at the operator's control desk for his convenience whenever he wants to know the loop height. Auxiliary relays may be used with the loop position meter to light lanterns mounted along the wall of the pickling building.

Smoother control gives more uniform pickling. The better control is due to the use of an all-electrical system with ample power, sensitivity, and speed of response. These characteristics are obtained using the amplistat and rotating regulator in combination and result in close control of loop position, maximum steel under acid, and minimum down time. Amplistats and rotating regulators work together to produce more pickled steel of higher quality at lower cost.

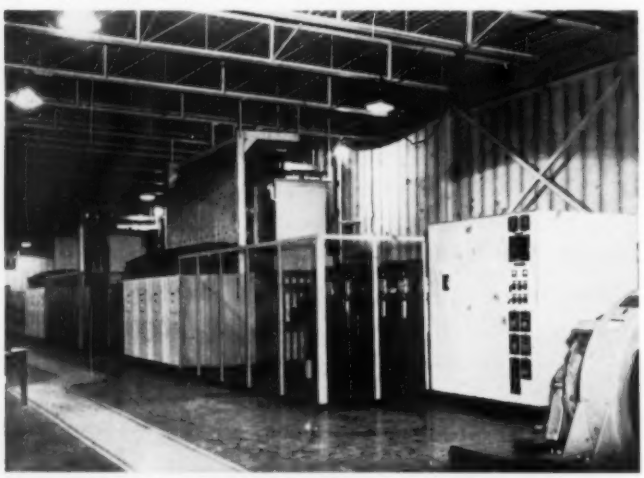


Figure 17 — Two 5000-kw, 750-volt ignitron mercury-arc rectifier equipments utilize amplistat type phase control for hot strip finishing mill service.

Hot strip mill power supply — Two hot strip finishing mills are now in service in this country, having their main drive motors powered entirely by mercury-arc rectifiers controlled by amplistat regulators. The first was placed in service in 1950 and the second early in 1952. The operation of these mills to date completely bears out the expectations for this type of conversion equipment and regulating equipment for tandem hot strip finishing mills, and similar applications. Figure 17 shows the two 5000-kw, 750-volt d-c rectifiers supplying power to the main drive motors on a 54-in. 4-stand hot strip mill. Such a mill normally operates at 750 volts on the main bus, but the voltage can be varied from zero to maximum for starting the mill, by means of phase shift control of the ignitors. The phase shift and excitation circuit is of the static-tubeless type (no moving parts and no vacuum tubes) providing maximum dependability and minimum maintenance. The

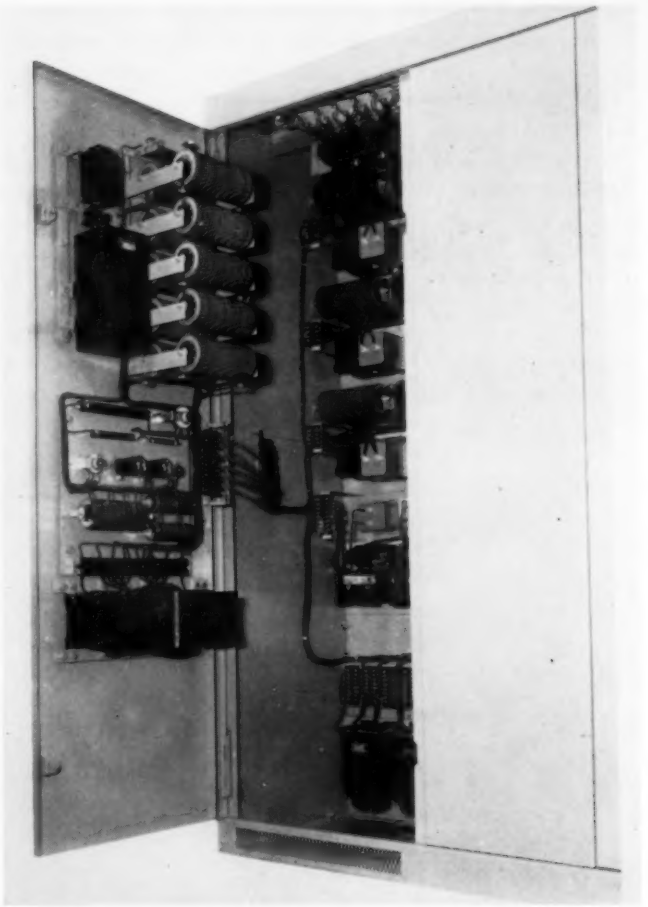
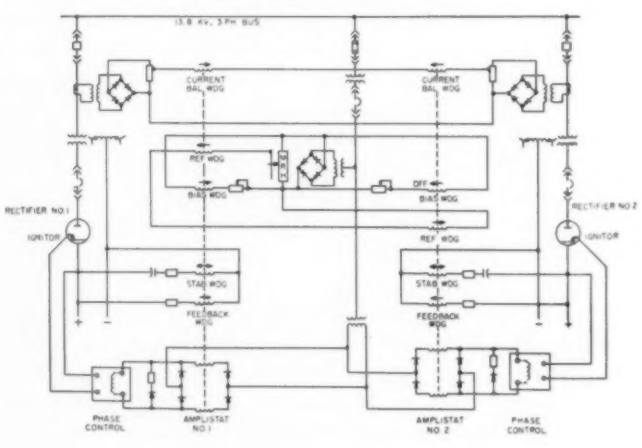


Figure 18 — Amplistat voltage regulator and phase control equipment for ignitron mercury-arc rectifier.

voltage regulator is likewise a static and tubeless amplistat, and is shown in Figure 18. A schematic diagram of the amplistat regulating circuits for the two 5000-kw rectifiers is shown in Figure 19. It will be noted that the single phase bridge circuit of Figure 7c is used. Phase shift control for starting the mill is obtained by operating the master rheostat (MRH). The amplistat regulator is seen to provide current balance as well as voltage regulation. The particular equipment illustrated is also capable of being operated continuously down to 575 volts if desired.

The transient performance of the equipment is illus-

Figure 19 — Schematic diagram shows amplistat regulating circuits for two 5000-kw rectifiers.



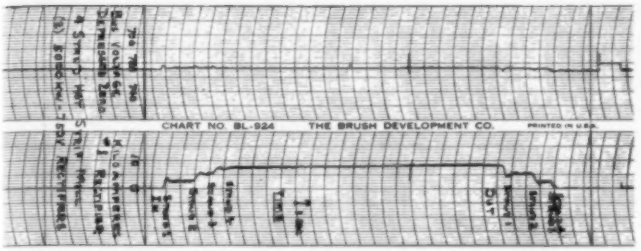


Figure 20 — Transient performance of 5000-kw ignitron mercury-arc rectifier using amplistat type regulating system. Oscillogram of bus voltage is taken using depressed zero to obtain expanded scale.

trated by the inking oscillograph and photoelectric recorded charts in Figures 20 and 21. Figure 20 shows rectifier No. 1 kilo-amperes and bus voltage while operating at 720 volts. The bus voltage chart was taken using a depressed zero to obtain an expanded scale. The maximum transient voltage drop is approximately 4 volts while the regulating accuracy appears to be approximately 2 volts for approximately 120 per cent change in rectifier load. Figure 21 shows a similar test but with bus voltage taken with a normal scale. The maximum transient dip in voltage is again seen to be approximately 4 volts with no perceivable change in steady state voltage with a 90 per cent change in load current. The amplistat output current is shown in the lower graph of Figure 21. In all cases, the maximum transient change in voltage appears to occur when the strip enters stand 1. It will be noted that the amplistat makes its full change in output current for this load

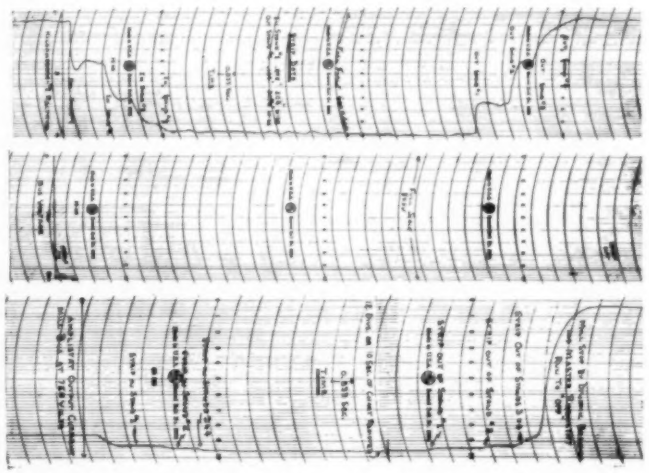


Figure 21 — Photoelectric recorder charts illustrate transient performance of 5000-kw, 750-volt, 6667 ampere ignitron mercury-arc rectifier with amplistat regulator used on hot strip finishing mill.

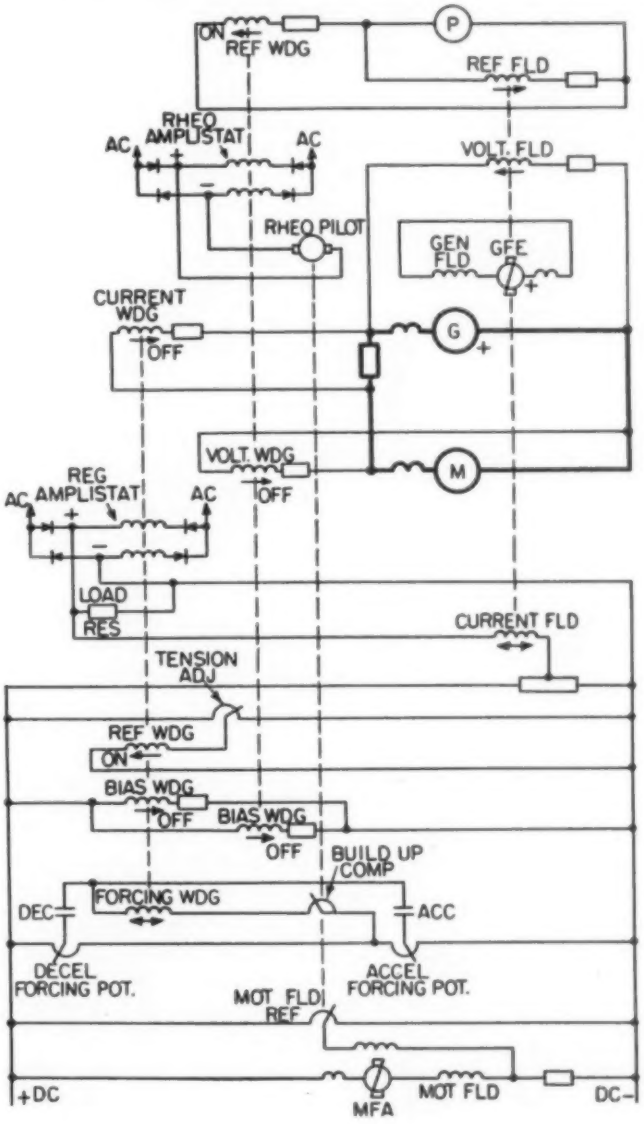
change in approximately 0.4 sec. However, the inking oscillograph chart in Figure 20 indicates system transient performance somewhat better than that.

The amplistat has been an outstanding success in controlling the voltage of the ignitron mercury-arc rectifier. Approximately 200 equipments have now been built and some have been in service as long as since 1948. The charts in Figures 20 and 21 show transient performance better than any previous system. Actually, the amplistat is ideally suited to the characteristics of the ignitron rectifier. Both are non-reversing, and both have time constants shorter than the required system time constant. This type of system can be stabilized by using the rate feedback of the output voltage. Only a few capacitors are required. Thus, the amplistat ignitron mercury-arc rectifier voltage regulating system gives unmatched performance with the minimum of auxiliary components.

Current and tension control — Amplistats have been used in conjunction with rotating regulators in a large number of applications to regulate line current and thus control strip tension. In fact, one of the first steel mill applications was made on the winding reel of the Jones & Laughlin Steel Corp.'s 6000-fpm tandem cold strip mill. This installation has now been in service for over three years and has certainly proved the reliability and effectiveness of the amplistat in regulating systems.

Amplistats have since been used as pre-amplifiers in current regulating circuits on pullers on high speed temper mills as well as on winding reels. A modern combination amplistat-rotating regulator control circuit for the tension reel on a cold strip mill is shown in its simplified form (less stabilizing elements) in Figure 22. The system is arranged so that the reel generator voltage is proportional to strip speed. The pilot generator

Figure 22 — Simplified schematic diagram of amplistat-rotating regulator current regulator for tension reel.



driven by the mill motor provides the basic reference signal for the tension reel voltage regulating system (rotating regulator GFE). Reel build-up and automatic tension control are taken care of by current regulating amplistat. This amplistat acts to maintain constant reel motor armature current by changing excitation on the second reference field on rotating regulator GFE and thus changing the generator voltage. As the coil builds up on the winding reel, the line current will tend to increase because the reel tends to try to run too fast. The current regulator will then cause the generator voltage to decrease so as to hold constant current.

Windings of the rheostat amplistat are connected across the reel pilot P and the reel motor M. When the

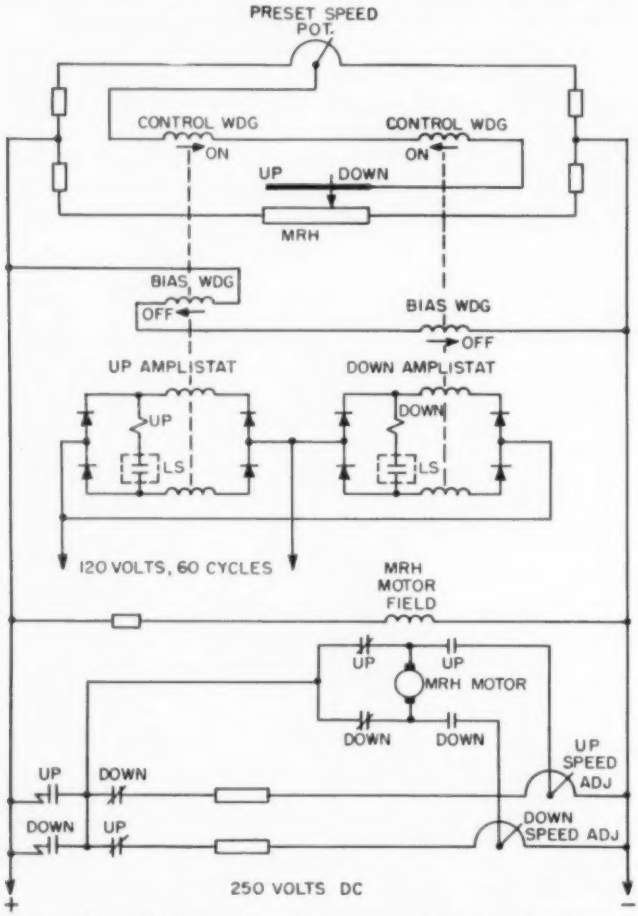


Figure 23 — This amplistat preset speed control system is used on cold strip mills.

motor voltage decreases, this amplistat is phased on. This amplistat supplies power to the rheostat driving motor which increases the shunt field excitation on the reel motor causing it to tend to slow down. The current regulator then restores the generator voltage to normal.

As a coil builds up, the regulating control system automatically increases the shunt field excitation to reduce the angular speed of the reel motor and to increase the motor torque in proportion to build-up to maintain constant tension in the strip. The motor field current regulating rotating regulator MFA is used to obtain precise control of the reel motor field.

The system has been designed to tend to have zero steady state error. In this system, not only is the line current being regulated, but the error is also being monitored and is periodically corrected. The transient response of the voltage control portion of the system is very fast. The sensitivity of the motor field current control portion is very high. Combined together as shown, amplistat and rotating regulator give an excellent current or tension control system.

Since the rheostat amplistat is non-reversing, the motor-driven rheostat position remains fixed when the drive is stopped and restarted. The regulating system thus "remembers" the coil diameter. An auxiliary dial may be used to recalibrate the "forcing" or inertia compensation required during acceleration and deceleration as a function of coil build-up. The rheostat is returned to its initial position when the mandrel is stripped.

The magnetic amplifier will undoubtedly continue to find more widespread use in current and tension regulating circuits. Experience obtained indicates that system performance can be improved through the use of magnetic amplifiers in conjunction with rotating amplifiers.

Preset speed control — Amplistats have been used in the position regulating system associated with preset speed control of tandem cold strip mills and temper mills. Two single-stage bridge amplistats have been used to measure the difference in potential between the preset speed dial and the dial of the master rheostat indicating the attained speed. A schematic diagram is shown in Figure 23. One amplistat is used to pick up an "UP" contactor and the other amplistat to pick up

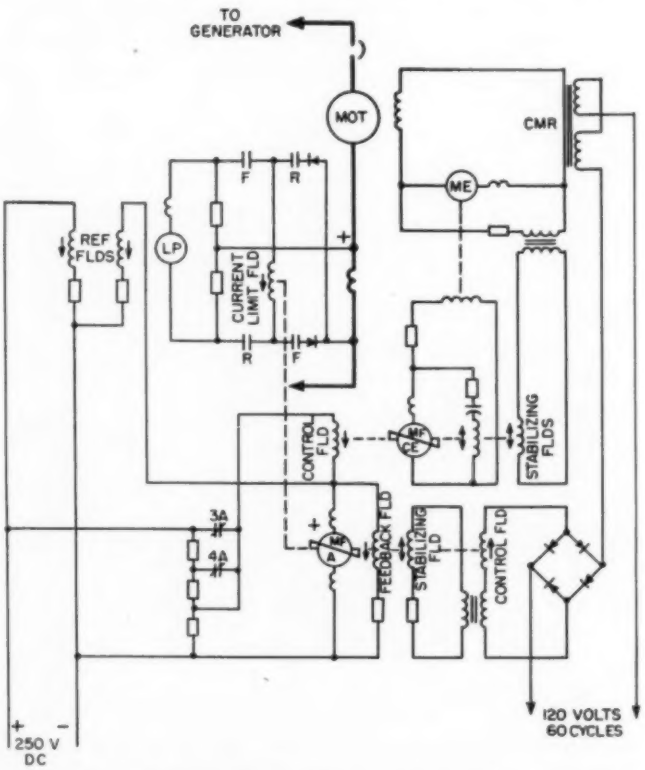


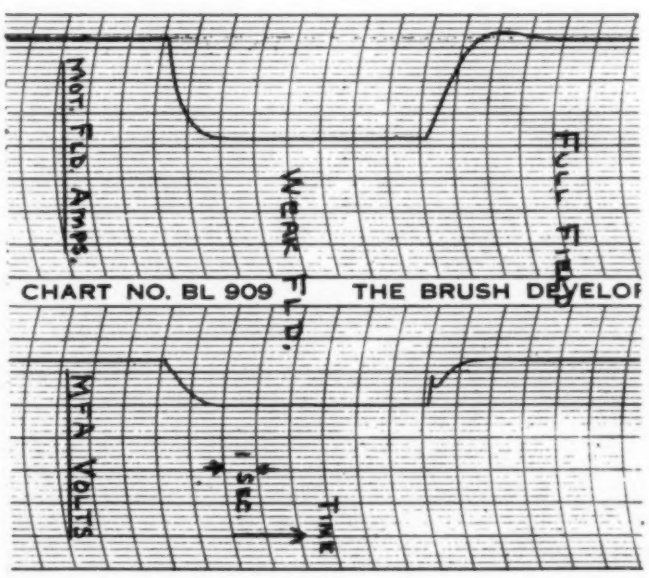
Figure 24 — Current measuring reactor-rotating regulator motor field current regulating system for reversing blooming and slabbing mill.

a "DOWN" contactor. The operation of the contactors, in turn, causes the rheostat motor to drive the rheostat either up or down until a voltage balance is obtained between the two potentiometer dials. Very accurate rheostat position control is possible due to the amplification in the amplistat units.

Current measuring reactor systems — The current measuring reactor previously described is now being used in steel mill regulating systems with very good success. A schematic diagram for a CMR system as used in the motor field current regulating system on the main drive motor driving a reversing blooming and slabbing mill is shown in Figure 24. In the past, a large cast grid resistor has been in use in series with the motor field. A current measuring reactor is now used to measure the current and to provide the feedback signal to the rotating regulator MFA. The a-c current output of the current measuring reactor is rectified by the means of the full wave rectifier. The d-c current flows through the feedback field on the rotating regulator and also through the primary of the stabilizing transformer. The secondary of the stabilizing transformer is connected to a second field in the rotating regulator. The output of the current measuring reactor is thus used to obtain the primary feedback signal as well as the rate signal for stabilizing the regulating system. The performance of this equipment has been found to be outstanding as illustrated by transient performance charts shown in Figure 25. It should be noted that there is absolutely no overshoot in motor field current when going from full field to weak field. Thus, there is no danger of the motor overspeeding or losing torque. The small amount of overshoot in motor field current when going from weak field to full field occurs as a result of system components being saturated, and since the motor is saturated as well, this overshoot has negligible effect upon motor speeds. Tests indicate that even though a substantial amount of inductance is introduced in the circuit by the primary of the stabilizing transformer that the rotating regulator control field current is substantially in phase with the motor field current.

The current measuring reactor has not been used in measuring circuits as widely in the steel industry as in the electro-chemical industry. This is probably due to the fact that the currents measured in the steel industry are, in general, a fraction of those measured in the electro-chemical industry. There has also been some concern over the fear of losing the a-c supply voltage to the current measuring reactor and thus losing indication of the load current. Also, while the shunts used in steel mill circuits may be considered to be large, they are not enormous as they are in the electro-chemical field.

Figure 25 — Oscillogram illustrates transient performance of current measuring reactor-rotating regulator motor field current regulating system as used on reversing blooming and slabbing mill.



SUMMARY

The magnetic amplifier has been proved to be a sturdy, reliable, and effective tool in regulating systems. However, it is not believed that in the immediate future the magnetic amplifier will replace entirely the rotating amplifier or the electronic regulator. Rather, the magnetic amplifier should be considered an additional method with clear-cut advantages on some applications, and equally clear-cut disadvantages on others. The magnetic amplifier will probably find the widest application during the next few years working in conjunction with the rotating regulator.

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DISCUSSION

PRESENTED BY

H. H. ANGEL, Electrical Engineer, Construction and Engineering Department, Bethlehem Steel Co., Bethlehem, Pa.

H. A. BARTLING, Manager of the Electronics Section, Power Division, Allis-Chalmers Manufacturing Co., Milwaukee, Wis.

T. B. MONTGOMERY, Engineer-in-Charge, Control Design, Allis-Chalmers Manufacturing Co., Milwaukee, Wisc.

R. W. MOORE, Manager, Control Development Section, Westinghouse Electric Corp., Buffalo, N. Y.

W. E. MILLER, Manager, Steel Mill Section, Industrial Engineering Department, General Electric Co., Schenectady, N. Y.

H. H. Angel: According to all reports, these installations are working very well. One or two amplifiers are in use in one of the Bethlehem Steel Co. plants.

When one looks at the diagrams, the first impression is that of complications, with transformers, resistors and rectifiers connected through a lot of wires. Since I have not had any practical experience with the amplifiers, I would like to know what aids have been supplied to assist the electricians in trouble shooting. Rotating regulators are likewise rather complicated, but after the early applications, miniature instruments were mounted permanently to assist the maintenance personnel.

In my second question, I would like to ask Mr. Miller if he has used 400 cycles for any of these applications to obtain faster response and better functioning of the circuits.

H. A. Bartling: 1. What range of phase-shift angle is provided for phase control in the rectifier regulator shown in Figure 19?

2. Is continuous operation from 750 volts down to 575 volts d-c mentioned for the equipment of Figure 19 obtained by phase control alone or by taps on the rectifier transformer?

T. B. Montgomery: There are a few comments I would like to make on Mr. Miller's excellent paper. When invited to discuss a paper a question comes to mind — what point of view should a discusser, who I take it should be a critic of the paper, assume? If he agrees thoroughly with the import of the paper, of what value is his discussion? I have assumed that the audience expects a discusser to take issue, where his conviction or experience is different, so that a cross section of experience or theory, or both, may be presented.

I thoroughly agree with the import of Mr. Miller's paper. Perhaps I can add to your concept of this new control tool, the magnetic amplifier, by presenting a different point of view.

The first portion of the paper gives fundamentals of the magnetic amplifier. The last portion describes control systems used in the steel industry where one or more components are magnetic amplifiers. What I have to say may be of more concern to designers, but I hope it will help complete a concept to us as application engineers. Let me emphasize, that even though all the components are magnetic amplifiers and d-c current transformers — which we call series transducers, the system is a feedback control. It is a feedback control system, whether the components are rotating regulators in combination with magnetic amplifiers or whether it uses only rotating amplifiers.

You have used feedback control systems in the form of fly-ball governors, and voltage or current regulators for a long time. Until 1937, your regulators depended on electro-mechanical contacts. Beginning about that year, what is now known as the feedback control was built up around the rotating amplifier and the electro-mechanical devices in the regulating circuit were largely superseded.

This system, as Mr. Miller says, continuously measures the regulated or output quantity, and this measure is continuously "fed back" and compared with a reference standard. The result is that equality or a constant ratio is regulated between them. If you prefer, the control is an electrical governor.

The magnetic amplifier is frequently termed a reactor because of its early use as a saturable reactor. We prefer to look at it as a cemf generator. As Mr. Miller has shown, it is a current regulator and you are accustomed to cemf's determining currents.

Referring to Mr. Miller's Figure 3, the difference between the supply voltage and the load IR drop or load voltage is the cemf generated by the magnetic amplifier.

We think of reactors as storing energy, energy largely stored in the air gap because of high values of exciting currents required to establish flux through an air gap. In any series or parallel capacitive-inductive circuit, there is an interchange of energy between C and L within each cycle. These devices follow sine waves, the current simply lags or leads. In a magnetic amplifier, however, we want no air gap, and as little energy storage as possible.

When I went to school, a-c theory was built largely around the sine-wave, and anything that deviated from it was to be eliminated if possible. Here, in the magnetic amplifier, we have a device that during a portion of each cycle generates a cemf by virtue of a changing magnetizing current. Therefore, there is little energy loss. At a controllable point, the cemf disappears with action like a grid controlled electronic tube. The tube, however, acts like a rheostat and therefore has an equivalent loss.

I second Mr. Miller's prediction that the magnetic amplifier's increasing application as a component of feedback control systems will continue, but that it will supplement rather than eliminate other types of components previously used.

As an example, the tin temper mill at Fairless works is a composite control, using seven feedback controls, each with components of magnetic amplifiers and rotating amplifiers.

R. W. Moore: Mr. Miller has presented to us an informative and interesting paper describing the operation of the magnetic amplifier. I agree that the magnetic amplifier will not entirely replace the rotating amplifier or the electronic amplifier in regulating systems for the steel industry. However, I do not agree that the magnetic amplifier will find its widest application during

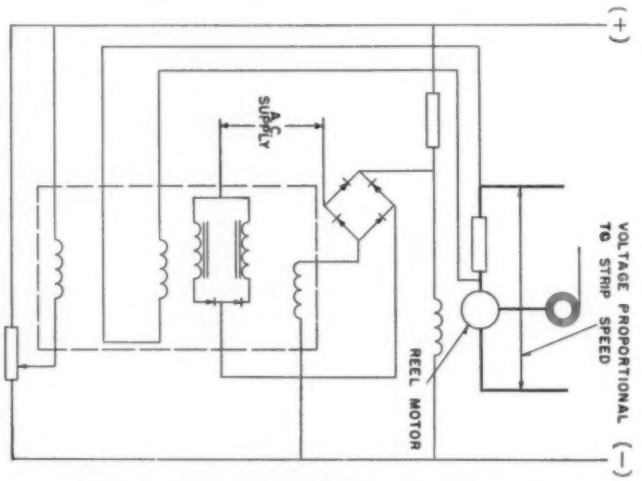


Figure 26 — Current regulator for reel drives.

the next few years working in conjunction with the rotating amplifier. It is generally not necessary to complicate the apparatus by using two types of amplifiers. Considering such factors as reliability, simplicity, ease of installation and maintenance, accuracy, response, amplifier characteristics and special drive features, studies of a variety of regulating systems have resulted in the following conclusions.

1. On a majority of applications it is possible to choose specifically one of the three types of amplifiers which provide the optimum in performance based on these factors.
2. For a number of applications such a study will

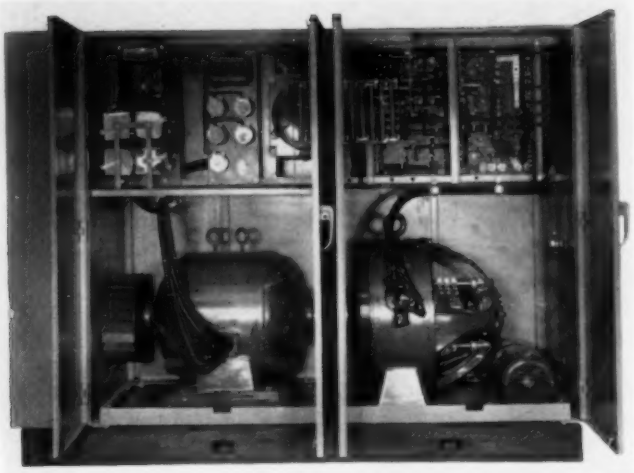


Figure 27 — Control for package drive mill is very compact.

reveal that there is little or no advantage between either of two of the three types of amplifiers.

3. For a few applications, a combination of amplifiers will give the best results.

To illustrate the results of such studies which my company has made, the following specific applications of magnetic amplifiers are of interest.

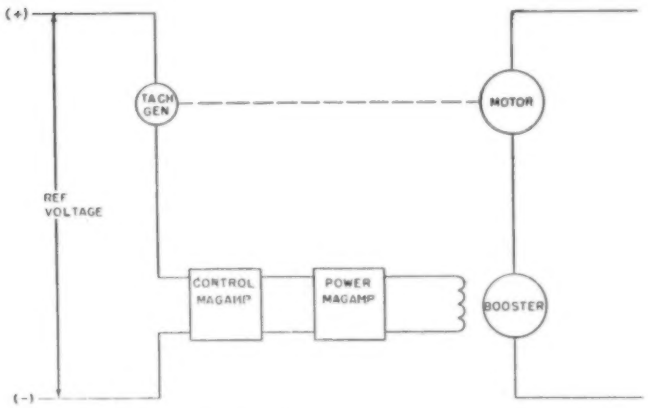
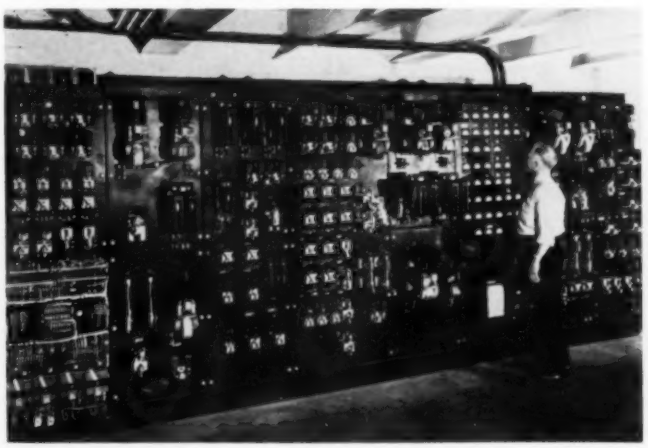


Figure 28 — Schematic of a speed regulator using magnetic amplifiers.

Figure 26 is a schematic of a current regulator for a reel drive. The magnetic amplifier controls the current and therefore the tension by modifying the motor field as the coil diameter increases. Full advantage is taken of the unidirectional characteristics of the magnetic amplifier since motor field current must be regulated upward from some minimum value and never reversed.

Figure 29 — Installation of control panel with magnetic amplifier speed regulator.



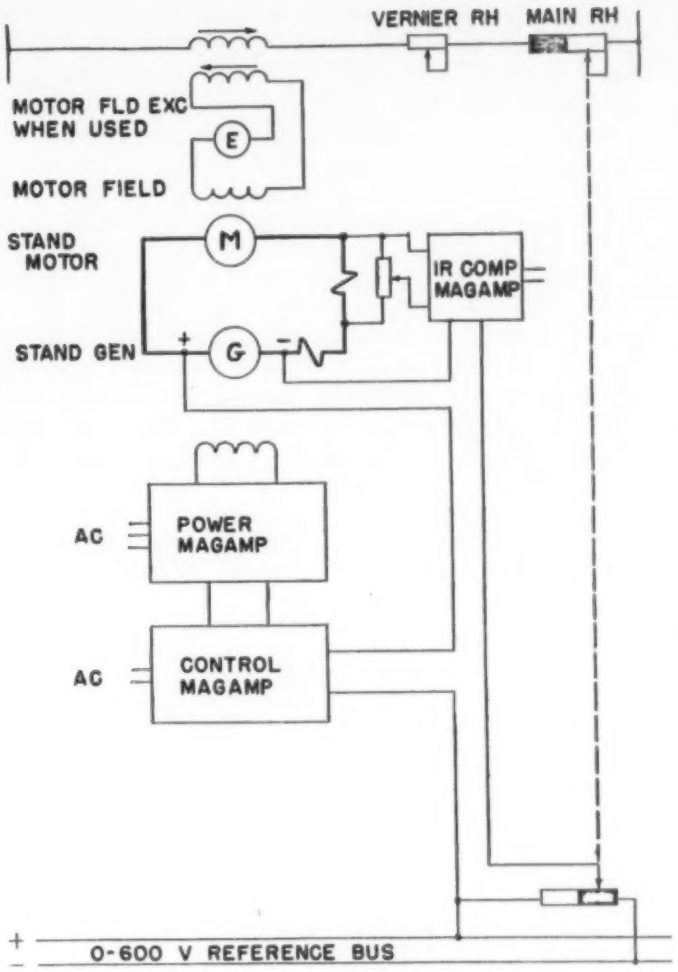


Figure 30 — Schematic of magnetic amplifier tandem mill control.

Figure 31 — Response of tandem mill regulating system.

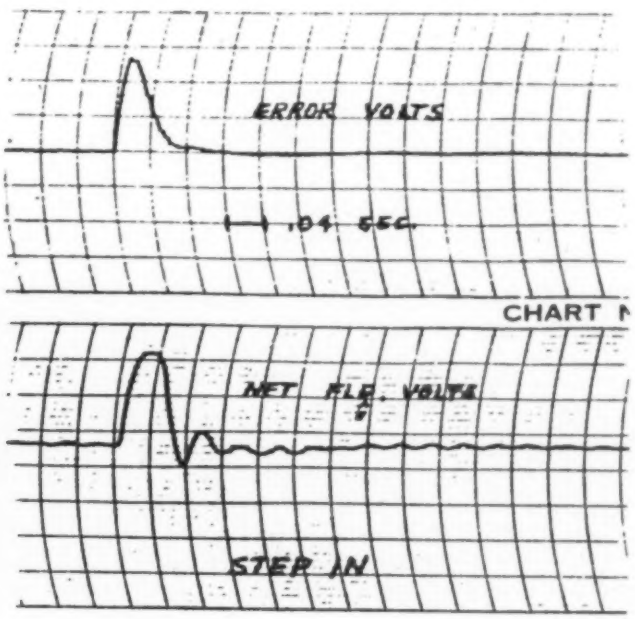


Figure 27 shows a control for a package drive mill using a magnetic amplifier reel current regulator. The magnetic amplifier is located in the upper left hand section of the cabinet.

Figure 28 is a schematic of a magnetic amplifier speed regulator and Figure 29 shows the installation of a processing line control using such a regulator. The magnetic amplifier is located in the lower left hand corner of the control panel.

Figure 30 is a schematic of a magnetic amplifier control for tandem mills. An oscillogram of the transient response of this system in shown in Figure 31. The ultimate in speed of response with critical damping is obtained by using 400-cycle magnetic amplifiers.

Figure 32 shows the magnetic amplifier panel of a voltage regulator for ignition rectifiers. Three such voltage regulators are to be installed shortly for control of the bus sections of a hot strip mill.

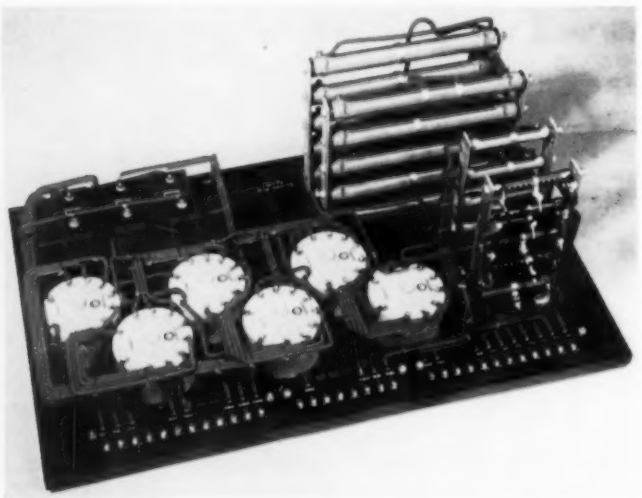


Figure 32 — Magnetic amplifier panel for ignitron voltage regulator.

Some of the many applications using only magnetic amplifiers to do the full regulating job have been shown.

If the magnetic amplifier is used generally in conjunction with other amplifiers, full advantage of its possibilities are not obtained.

W. E. Miller: Mr. Angel raises questions as to the wiring complexity of magnetic amplifier equipment and the available trouble shooting aids. I am inclined to agree that possibly the control wiring is more complicated in the case of the magnetic amplifier, because the "insides" are exposed on the control panel. There are probably just as many or more connections inside the rotating regulator but the "working parts" are packaged inside the frame and end-shields. However, in both cases, I believe that the component pieces, that is, the transformers, the resistors, rectifiers, and the punchings, coils, and brushes are things with which we and our maintenance people are familiar. Therefore, I do not believe that either type of regulating system is more or less complicated than the other. In addition, both need the same kind of stabilizing circuits as well as electric reference and feedback signals.

As to maintenance aids, it has been our practice to supply the same permanently mounted miniature instruments on both types of regulating equipments. Another tool that is an aid in understanding and trouble shooting on regulating systems is the high speed of response inking recorder. Transient performance charts can be taken during trouble shooting, and system adjustments can be made based upon knowledge of what the charts should look like, or by actual comparison with other charts previously taken when the drive was operating properly.

The electronic analogue computer is also an aid in understanding regulating systems. It is very easy to demonstrate the effect on system performance of changes in settings of resistors, capacitors, etc. In fact, in addition to analyzing systems, we have used our computer for such demonstrations. We have simulated the actual regulating system on the computer and demonstrated the expected system transient performance, as well as the effects of adjustments to customers' engineering, maintenance and operating personnel to aid them in understanding the operation of the system.

Use of higher frequency magnetic amplifiers will certainly result in improved system performance. However, a stiff source of 60-cycle power is usually always available while power supplies of higher frequency always have to be supplied. With small magnetic amplifiers working in conjunction with our two-stage rotating amplifiers, we have been able to obtain sufficiently fast system response without resorting to the use of frequencies greater than 60 cycles.

Mr. Bartling has asked some questions about the range of phase shift angle and operation of the hot strip mill rectifier described in the paper. Not being a rectifier engineer, I can only tell you what the over-all equipment is capable of doing. The particular equipment illustrated and that on which the charts were taken is capable of operating continuously, if required, down to 575 volts by phase control, not tap control. In addition, the equipment is suitable for intermittent operation down to zero voltage for starting the mill motors and accelerating them up to top voltage.

It is indeed interesting to note the wide divergence of opinion that apparently exists as to where the magnetic amplifier will find its widest application during the next few years. It is also pleasing to have one of the discussers agree so wholeheartedly when one of the others states that he does not agree.

Mr. Moore states that "It is generally not necessary to complicate the apparatus by using two types of amplifiers." I was not aware that combining magnetic amplifiers and rotating amplifiers complicated anything. After all, d-c exciters and d-c generators are rotating amplifiers. And, generally speaking, they will continue to be used in steel mill systems. Our form of rotating regulator is as standard as any handbook-listed d-c exciter and somewhat similar in construction except that it requires an extremely small amount of excitation.

It is still my belief, and it is apparently shared by Mr. Montgomery, that there are advantages in using combination magnetic amplifier-rotating amplifier regulating systems. There is a lower limit on the size of rotating amplifiers. There is a certain minimum frame size rotating amplifier suitable for use in 700 volt d-c circuits that will provide the continuity of service required by the steel industry. Thus, there has been a lower limit on the input power level required for the majority of steel industry regulating systems. Use of magnetic amplifiers in conjunction with rotating ampli-

fiers should broaden the field of application of non-electronic regulating equipment in the steel industry.

As an example of what I mean, let me again mention the magnetic loop control for pickling lines. Here a combination magnetic amplifier-rotating amplifier regulating system has resulted in an altogether new method of controlling the loop position in pickling tanks. The magnetic amplifier permitted enough reduction in input power level to make it possible to regulate the position of the steel strip entirely by means of its effect upon a magnetic field set-up in the acid. Here is a combination system that has had the widest possible acceptance. It is my understanding that it has been used on practically every continuous pickling line installed since its introduction. I noted one machinery manufacturer listing it as one of the features of his pickling line equipment in an Iron and Steel Engineer advertisement. I honestly believe that this system is simpler as a combination system, and that possibly we would have been criticized by the industry if we had developed it as an all-magnetic amplifier system.

I would like to again point out that we are supplying all-magnetic amplifier type equipments, as well as combination equipments. We have supplied some 200 ignitron mercury arc equipments with complete magnetic amplifier regulating systems. Some of these equipments have been in service as long as since 1948. You will recall the hot strip mill main drive photographs and performance charts shown in Figures 17 to 21, inclusive, of this paper.

Summarizing, I am confident that we will supply much apparatus during the coming years, such as that for reversing mills and processing lines, that will include in the over-all apparatus not only combination systems but also all-rotating amplifiers, all-magnetic amplifiers, or these in combination with electronic amplifier equipments. I do not believe that the steel industry will consider such equipments any more complicated than it has in the past, so long as we exercise good engineering judgment in the application of our regulating equipments.

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EXPLORATION AND DEVELOPMENT OF A NEW ORE MINE

By R. P. BREMNER

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. . . . a great deal of engineering planning is required before a new mine may be opened . . . .

▲ MOST technical men are well acquainted with the iron and steel industry's increasing need for additional iron ore to feed the new furnaces erected under the present expansion program and to replace the declining Lake Superior ore reserves.

During the past few years, a great deal of publicity has been given to the discoveries of new foreign iron districts and the research work on concentration of Lake Superior taconites. Anyone associated with the industry has had opportunity to become informed on the results of the intensive search for new iron ores by reading the numerous articles in trade papers and magazines.

These articles, in a broad way, have presented the colorful aspects of prospecting, general exploration, and transportation for these new iron deposits. They have generally steered clear of the technical problems which have to be solved to actually delineate and develop these new ore bodies. This paper has been written as an attempt to present the geological and engineering riddles that must be thought out and answered by the geologists, mining engineers, and business men who are working on the expansion of the world's iron reserves.

It is not just a geographical coincidence that the majority of new foreign iron ore developments are located around the shores of the Atlantic Ocean. Only cheap water transportation can offset the long distances from consuming steel centers. At present, it is a basic requirement that the delivered cost of foreign ore to Youngstown, Cleveland, and Pittsburgh must be competitive with the delivered cost of Lake Superior ores. The new ores discovered in Venezuela and Labrador are located some distance inland from the sea lanes. The added rail haul to water is an extra cost burden on these foreign ores and demands that the cost of ore FOB mines be as low as possible.

The size and character of the Lake Superior ore deposits plus cheap water transportation made their exploitation possible despite their great distance from blast furnaces and mineral fuel supplies.(1)* The easy accessibility of the large ore deposits, especially those on the Mesabi range which are near the surface and of a soft earthy nature, assured low mining costs.

The question of whether or not a new iron deposit will be acceptable as an ore is one of costs. These costs are determined by:

1. The analysis and texture of the ore and its impurities.
2. The cost of mining.
3. Whether the ore is suitable for direct shipping or has to be beneficiated.
4. The cost of transportation to the steel plant.
5. The cost of reduction in the furnace, depending on the character of the ore.
6. The nature of the ownership or consumer. A vertically integrated steel company with large financial resources is more apt to shoulder the great capital investments needed to develop a new iron district in order to assure itself of an adequate ore reserve than is a smaller company with inferior financial resources.

The search for iron ore has been vigorously pushed for many years. It involves great expense and human

*Numbers refer to Bibliography at end of paper.

effort through Arctic wastes or jungle wilderness, difficult to penetrate and explore. Many of the recently reported new iron discoveries have been known for many years. At Steep Rock Lake, the Oliver Iron Mining Co. discovered an orebody in 1901; but the property was not developed.

A Canadian provincial geologist, A. P. Low, noted the occurrence of pre-cambrian iron formation and iron deposits near Menihek Lake and the Hamilton River in the now famous Labrador district in his report dated 1895.

Ruins of a Spanish furnace and hammered blooms at least 150 years old have been found in Venezuela. Attempts to mine and ship Venezuelan iron ore to the United States were made in 1901 and during the period 1911 to 1913 from the Manoa ore deposit near the Orinoco River. The Pao deposits, now being mined by Bethlehem, were discovered and explored in the 1920's. Further prospecting by the U. S. Steel Corp. resulted in the discovery of the large Cerro Bolivar deposit in 1947.

The Helen Mine of the Michipocotan District was discovered in 1897.

The high grade hematite reserves in the State of Minas Geraes, Brazil, were first reported in 1910. Explorations for gold had been made in the iron formation nearly 200 years before. The iron ores are found in pre-cambrian iron formations which were originally laid down as sediments in the same geologic time period that spawned iron formations in the Lake Superior, Labrador, and Venezuela regions.

Since the advent of large capital into these regions, exploration has been systematized and now includes the complete geologic, topographic, and magnetic mapping of the areas to be explored.

EXPLORATION FOR IRON ORE

In order to determine whether or not a new ore discovery may be economic to develop and mine, it is necessary to ascertain the size, dip, grade, and physical nature of the deposit. This may be accomplished by test pitting and shaft sinking, exploratory churn and diamond drilling, and magnetic mapping by dip needle or airborne magnetometer.

Test pits may be sunk by hand or excavated by bulldozer or power shovel. Normally they are shallow and controlled by the nature of the ground and the elevation of the water table. Shafts which may require timbering and water pumping equipment as well as hoisting machinery are expensive and slow. These excavations reveal the nature of the overburden and the structure and hardness of the ore.

Exploratory churn drilling permits accurate sampling of each five-foot vertical run in ore and gangue. The diamond core drill, a more expensive form of drilling, permits a core recovery to give visual records of the geology and texture as well as accurate analyses of buried formations. The great dependence placed on drill work has resulted in enormous expenditures in the Lake Superior region and elsewhere.

All iron ores are found to be magnetic when tested by sufficiently delicate means.(2) Ordinary magnetite is the only mineral which causes conspicuous disturbance of the magnetic needle. Strong magnetic disturbance does not necessarily mean ore, and, vice versa, ore does not necessarily cause strong magnetics. In the search for iron ores of the Lake Superior and Labrador type, the magnetic attractions are useful in locating iron bearing formations, but do not directly point out the iron ores themselves. The dip needle determines the vertical component of the magnetic pull, as well as the direction of the horizontal pull. The airborne magnetometer has recently been found useful in outlining deeply buried magnetite orebodies in Ontario and Eastern Pennsylvania. The ore or formation outlines are obtained by accurately plotting magnetic profile cross sections and drawing in the contours of equal magnetic intensity.

Interpretation of structural geology, as the information from test pitting and drilling is gathered, is the key to success or failure in an exploration program. Orebodies below surface may be completely missed because of lack of information on the structural controls of ore formation. Valuable time and money may be wasted through incorrect analysis of the geologic data. For this reason the larger companies investigating new iron regions have developed competent geological staffs.

CHOICE OF MINING METHODS

The mining company has to determine through exploratory prospecting the size and extent of the orebody; its depth below surface and dip; its relation to drainage; and the strength of the ore itself and of the enclosing rocks. The choice of a suitable mining method will also involve the cost of labor, equipment and supplies, market price of, and the demand for ore.

There are two basic mining methods: open pit, and underground. The relative advantages of open pit over underground mining have been constantly increasing during the past half century. If an orebody is near surface, flatly dipping, and of large lateral extent, the ore may be mined on a mass scale — as an open pit — with large and powerful drilling, loading, and haulage equipment which permit marked labor economies. The advantages in favor of *open pit mining* are:

1. Open pits are cheaper to explore and delineate.
2. Open pits have unlimited vertical and horizontal working ranges.
3. Timbering, requiring a large percentage of labor in underground mining, is not required.
4. Drilling and blasting is cheaper because of presence of two and three faces to break to.
5. Drainage is cheaper because of the shorter vertical head.
6. No artificial ventilation is required.
7. Shorter vertical haulage distance with capacity limited only by number of haulage and loading units.
8. Open pits are more flexible in operation with rapid increase or decrease of production capacity possible.
9. During shut-down periods, the idle cost is low. Maintenance of haulageways and replacement of timbers is mandatory in underground operations.
10. The labor requirement for a given annual open pit production is only one-third or one-quarter of an underground mine.

11. A larger proportion of the working force at underground mines is skilled labor.
12. Open pits permit a greater recovery of the orebody.
13. Less safety hazards to men and machines.
14. Less danger of catastrophes, such as fire or flooding.
15. Total cost of mining is much less than that of underground mines.
16. Less dilution from impurities.

The advantages in favor of *underground mining* are:

1. Shallow underground mines do not require the relatively high initial outlay of capital for development purposes.
2. Development can be spread over a larger period of the life of the mine.
3. Underground operations can work the year around and are not shut down by winter weather.
4. Cloudbursts can temporarily shut down pits.
5. Horses of rock in an underground mine may be left in place during mining. Often they have to be removed in mining a pit.
6. The necessity of dumping waste stripping from open pits on non-mineral-bearing land may involve long hauls.
7. Mining by the open pit method necessitates the removal of all material in the pit overlying the ore, whereas this is not necessary in underground mines.
8. Royalty rates are commonly higher on direct-shipping, open pit ores.

DEVELOPING AN OPEN PIT

The orebodies that will be mined first at Labrador and Venezuela will be developed as open pits. These ores are either close enough to surface or big enough to be developed on a large and comprehensive scale with the latest cost-saving techniques.

The Cerro Bolivar deposit in Venezuela outcrops at hilltop and is as long as the great Hull-Rust, Mahoning open pit on the Mesabi. With practically no stripping necessary, it will lend itself to open cut work from benches on the hillside — the cheapest kind of mining. U. S. Steel Corp. has indicated that the loaded ore will move down hill from the crusher and loading pockets via belt conveyors to a proposed screening and sintering plant.

None of the presently explored Labrador orebodies indicate another Mahoning-Hull-Rust pit. However, the orebodies are shallow in depth and are covered by glacial debris overburden averaging only about 15 feet. Areas for dumping waste are abundant. In all probability, the length of haul to stripping dumps will be short.

At Steep Rock, the middle or "B" ore zone now in production was developed as an open pit, after draining a portion of the lake and removing the lake bottom silt. Because of the steep dip and narrow width of the ore zone, the technological problems have been great, and a good deal of capital investment has been necessary to uncover and keep uncovered the ore for production. After 1953 this pit will be replaced by an underground mine.

The following description of practice in the Lake Superior district will be followed in general in developing new foreign orebodies.[3] After the orebody has been drilled, the exploration holes, topography, and property lines are located with respect to a system of 100-ft interval coordinate lines. Since the drill holes were spotted originally on cross section lines, two sets of sections at right angles to each other are laid out from the drill records. Analyses of each 5-ft run are placed at the proper depth on each hole. It is then possible to outline the layers of different ore grades on each cross section. From the sections, a plan is made showing surface contours and the top and bottom of the orebody, and its probable lateral limits. In order to estimate tonnage, the area (from planimeter measurement) is multiplied by the average depth and divided by the cu ft per ton.

From the cross sections, the proper berm distance is laid out between the edge of the orebody and the toe of the bank of overburden. Slopes of 1:1 or 0.75:1 are selected for the banks, dependent on the character of the overburden. The average area to be stripped multiplied by average depth and divided by 27 gives the cu yd of stripping.[3]

In order to estimate stripping costs, the following ratios are used: cu yd of overburden per ton of ore uncovered, or tons of stripping per ton of ore. Glacial overburden averages 1.6 tons per cu yd, while rock may weigh over 2.0 tons per cu yd. In 1910, on the Mesabi, it was generally considered that the economic limit of stripping was reached with the ultimate removal of not more than one cu yd of overburden for each ton of ore.[1] Since 1910 better equipment and an increased demand and price of ore have made it possible to enlarge these ratios significantly. Some of the recently developed open pits have been stripped with ratios as high as 5 to 7 tons of overburden per ton of ore.

Many of the large pits, when originally developed years ago, had marginal ore zones which were not uncovered during the general stripping programs. These were uneconomic for open pitting at the time and were considered as future "scram" ores. In recent years, some of these marginal ores have warranted open pit development along with the main pits. Increment stripping, where the major equipment is already on hand, may permit economic ratios as high as 5 to 10 tons of stripping per ton of ore.

Stripping costs vary with the nature of the overburden; 20 to 50 cents per yard for glacial material, and 75 cents to a dollar and a half per yard for rock.

An idea of the tremendous amounts of material of all types that have to be handled can be imagined by considering the famous Hull-Rust-Mahoning pit. By January 1, 1951, 386,625,000 gross tons of waste and 496,560,000 gross tons of ore had been removed.

Overburden is stripped by electrically operated shovels or draglines and is hauled to waste dumps by trucks or conveyors. The engineering problems involved are largely those of selecting proper equipment, and arrangement of truck roads and approaches. Common stripping equipment includes revolving, cat-mounted shovels with 8 to 10-cu yd dippers. Smaller shovels of 1.5 to 3 yd are used for shallow clean-up work. The average diesel-operated truck can haul 20-ton loads at grades of 8 to 10 per cent. Experimental units up to 50 tons capacity are now being tested. Stripping faces for power shovels and truck haulage ordinarily have a 1:1

slope with a 20-ft berm at the bottom of the bank. In deep overburden the banks are broken every 75 ft vertically with a 25 to 30-ft berm. The shovels work against a 30-ft bank. As the top surface of orebodies is uneven, the stripping stops a few feet above the ore, and the final clean-up is accomplished by scrapers and smaller shovels.

The popular shovel for loading ore is full-revolving, cat-mounted, and electric with a 4 or 5-yd dipper. The same trucks are used for stripping and ore haulage. Road grades of 8–10 per cent are feasible for loads, and on return 20 per cent is permissible.

If belt conveyors are used to move the ore from pit to car loading hoppers, the ore is loaded into trucks and hauled to a centrally located pocket. A crusher is stationed between the pocket and conveyor. A 30-in. wide conveyor at maximum 19 degree inclines can handle 300 tons per hour at a speed of 350 fpm.

Additional equipment for mining a pit must include pumps, road graders, 6-in. churn drills, bulldozers, blacksmith and machine shops and other mine buildings.

The ore is mined in a series of benches until the ultimate pit slope is reached, and the pit bottom area becomes too small to operate in. Any ore remaining in the pit at this time would have to be mined by some underground method, such as "top slicing." This clean-up operation is called "scramming."

The average total investment cost covering exploration, development, and equipment for Mesabi open pits was under $2.00 per annual ton of capacity prior to the second World War. Low stripping ratios, and the high quality of many of these orebodies made it possible for such a low average figure.

Properties opened during and since World War II have had to bear heavy increases in labor and equipment costs. The relatively few remaining high grade orebodies under shallow glacial overburden now cost $4.00 to $5.00 per ton of annual capacity. However, deeper cover, need for beneficiation, and removal of large quantities of rock may increase this cost to $14.00 to $15.00 per ton.

DEVELOPING AN UNDERGROUND MINE

Although reports on the new foreign ore developments make no mention of presently contemplated underground operations for orebodies, new underground mines are currently being developed in the Lake Superior district. Also, it is entirely possible that much of the narrow, deep ore at Steep Rock will be won by underground methods.

The basic features of the fundamental underground mining systems had been developed by about 1895.(1) However, the methods now in use have been greatly improved so as to adapt them better to natural conditions and new equipment. Labor productivity has increased by constant improvement in the established methods.

Top slicing, *sub-level stoping*, and *sub-level caving* are three methods most commonly used in the Lake Superior district. The *sub-level stoping* method is particularly well adapted to orebodies that are not too soft and whose wall rocks are fairly hard and firm.

A few iron mines have used a mining system called *block caving*. In this method blocks of ore as large as 250-ft square and from 150 ft to several hundred ft in height are entirely or partly cut off from adjoining blocks by narrow open stopes. The blocks are then undercut with drifts and crosscuts, and the remaining pillars weakened by drilling or blasting. The blocks are then allowed to settle for as long as a year, during which time they are sufficiently broken up by their own weight to be drawn through raises and chutes at the bottom. Although this method requires a higher initial development cost than other methods, once the blocks have been developed and the ore is being drawn, it permits a higher output per man than any other underground mining method yet developed.(1) This efficient method is inapplicable in most soft orebodies in the Lake Superior district because of the physical nature of the ground. The Errington open pit at Steep Rock will be converted to a block caving underground operation. Ore will be brought to the surface by conveyors.

The soft ores of the Lake Superior District present a special problem in mining because the ore will not stand without support and has but little strength when left in pillars.

The *top slicing* system of mining, which was developed in England, has proved satisfactory for the mining of soft orebodies with a weak or unconsolidated roof. The orebodies are developed by driving drifts and crosscuts at level intervals of 100 ft vertically and putting up raises to the top of the orebody or the level above. Mining starts at the top and works progressively downward. The ore is won by a system of parallel timbered drifts or slices — one alongside the other. They are driven to the end of the orebody, or a predetermined limit. Wire mesh and planking are laid to cover the floor and reduce contamination from the surface material in mining below. When one or two slices have been completed across the orebody, the supporting timbers are blasted out and all of the overlying surface material is allowed to cave, filling the slices solidly. After the top of the orebody has been sliced off in this manner, slices are started on the sub-level below, the timbers being set directly against the planking of the "sub" above. After several slice levels have been mined, a protective mat or "gob" of timber and waste is formed. The top slicing method is one of high cost because all ore removed has to be drilled and blasted, and timber consumption is at a maximum.

The *sub-level caving* mining method was a natural development from top slicing. It has been widely adopted in the Lake Superior region and today is the most commonly used underground system for the mining of soft ores. It differs fundamentally from top slicing in that some ore is left on each side and above and below the advancing slice. Vertically, the sub levels, instead of being 10 or 12 ft apart are spaced 20 to 30 ft. When the slices are retreated, the ore is drilled and blasted to the adjacent slice and the sub above. A necessary requirement for efficient operation is that the cave follows continuously down and does not hang up above the workings. If it hangs up, there is danger of sudden collapse from resulting pressure which may crush the workings below. More serious, a cave hanging up which allows water to build up in the gob may let loose with a mud run threatening the lives of miners below.

The ore is transferred, after blasting, by hoe type scrapers and electric hoists or "tuggers" from the slices

to transfer chutes or storage crosscuts for loading into mine cars on the main haulage level below.

If the capping or overlying rocks are hard and tough, a sub-level caving system cannot be initiated until a large enough opening has been made to start caving. In this event, the upper ore is mined by an open stoping system. The sub-levels are developed as for caving, but are mined by enlarging a vertical raise or opening into an increasingly large untimbered hole or stope. When this can no longer stand, the hanging and capping rocks cave in, filling the stope. From here on the ore is mined by a caving system.(4)

When the size, shape, and depth of an orebody to be mined underground have been determined, a hoisting shaft is located in country rock opposite the deepest part of the orebody. Consideration must be given to disturbance by subsidence, and surface topographical features to accommodate stockpile ground, plant space, timber storage, and railway connections. Safety and ventilation require a second shaft for all large underground operations. Shafts may be sheared and lost and surface buildings may be damaged by ground movement if located within subsidence limits. The cost of replacing these facilities may be so great that subsequent mining may be economically impossible.

Sinking a shaft through deep surface material is an expensive and oftentimes hazardous procedure. Where an orebody is located under glacial sand and gravel overburden that is heavily charged with water, getting the shaft to ledge is a serious problem. In the iron ranges of Upper Michigan, several recent new underground properties have been developed in the following manner. Sinking through quicksand to ledge was accomplished by the drop shaft method. From a preliminary pit 15 or 20 ft deep, the reinforced concrete shaft lining is formed to project above surface. The bottom of the drop shaft is made with a steel cutting shoe, V-shaped in cross section. As the ground is excavated under the shoe, the weighted concrete structure sinks into the ground. The concrete walls are built up as sinking proceeds. If the friction is greater than anticipated, additional weight in the form of pig iron, or sand may be added to the walls. Excavation is done by clamshell bucket. In order to keep out an inflow of quicksand or soft ground, an airtight deck is installed in the shaft, and compressed air is used to drive out the water from the interstices in the ground, so that men can work in the shaft bottom. When the cutting edge has reached ledge, a watertight seal is made to the rock. After the seal has been completed, sinking resumes in rock in the normal manner.

Most modern shafts are protected by steel H-section sets, spaced 6 or 8 ft apart vertically, and treated wood lath. These sets are hung on bearing beams concreted into rock hitches every 150 or 200 ft. A modern hoisting shaft is usually designed with six compartments: two for skips; two for man cages; one for water, air, and power lines; and one compartment for a ladder road. Since the most laborious part of sinking, mucking or loading rock, consumes 40 to 60 per cent of the working cycle, scrapers and hydraulically operated clam-shells have been used, instead of hand mucking. Despite these labor-saving methods, the average sinking speed in hard granite for modern sized shafts is only about 200 ft per month. This is no faster than sinking progressed twenty years ago, in spite of further mechanization. Meanwhile, the overall cost per foot of completed shaft has doubled in the same period. The cost of sinking a vertical shaft in granite is not far from $500 per vertical ft. When this figure is multiplied by several thousand feet, depths already attained by several Michigan iron mines, the cost of shaft alone is tremendous.

The economic level interval in any mine is a matter of experience. This may vary from 100 to 300 ft. At great depths, it may be necessary to crosscut a half mile or more to reach the footwall of the iron formation. Crosscutting or tunnelling costs in granite approximate $70 per lineal ft. Because of the enormous expenditure of rock work per ton of ore developed, levels are opened up from the shaft only where and when needed. The top level that is opened up is provided with sump capacity and pumping equipment to pump all the water the mine produces to surface in one lift. Large reciprocating pumps are used to pump against a vertical head of half a mile. The succeeding levels will be provided with smaller sumps and pumps necessary to lift water to the next higher level only. Transformer stations, ore dumps, and pockets, and material storage space all have to be provided underground before ore can be hoisted.

When the shaft sinking has been completed and the level stations are cut out, the temporary sinking equipment has to be replaced with permanent cage hoists and skip hoists and ropes. Water discharge lines, air lines, and power cables are installed permanently in the shaft. The ladder road is sheeted off, and if the shaft is to be used as a fresh air intake, the permanent shaft house and headframe must be made airtight and provided with heating facilities to warm the cold winter air.

While sinking is progressing, a vast amount of construction and earth leveling is going on at surface. Even soft ore mines are now being provided with crushing facilities. Conveyors and car loading stations are installed for summer ore loading and permanent trestles and separate stockpile grounds must be provided on which to dump all rock and the winter's ore production. Railroad tracks and water and sewer lines have to be laid. The main mine buildings, capable of withstanding rigorous winters, include the main engine house where hoists, compressors and motor-generator sets are housed; a machine shop, blacksmith shop, warehouse, and change house for men. Recent practice has been to include these under one roof, where possible. Finally the surface is graded for timber yards and roadways.

Underground, when the new level crosscuts have been advanced from the shaft to the face of the ore horizon footwall, drifts are turned right and left and driven either to the end of the ore or the property limit. At regular intervals, say 300 ft, exploratory crosscuts are turned off to pierce into and through the possible ore-bearing horizons. Later two compartment raises will be driven to the top of the orebody or to the level above. These will serve as ore passes and supply and ventilation avenues when the ore is mined. Raising is arduous and often dangerous work. Because of this fact, it is difficult to hire raise development miners. In turn the cost of driving raises is great.

This concludes the development process, until mining progresses far enough to require deepening of the shaft and the driving of new levels.

The present cost of developing an underground mine

is so large and the economics of mining underground is so close to the break-even point that only companies with experienced mining organizations and large financial backing will attempt to open up such a property. Total investment costs to explore, develop, and equip a new deep underground property may run from $15 to $18 or higher per ton of annual productive capacity.

As the known orebodies in the Lake Superior district, which are economic to mine by open pit methods, are mined out, new ore extensions will largely be recovered by underground mining. Thus, a trend to higher cost operations, which has become apparent for the region for some time, will be accentuated. Table I illustrates the basic cost differences between open pit ore, as exemplified by the Minnesota ranges, and underground ore which represents the major production from the Michigan ranges.

TABLE I[5, 6]

Costs Per Ton

Item Type of mines	Average all Minnesota Open pits		Average all Michigan Underground mines	
Period	5 Years 1946-1950	1950	5 Years 1947-1951	1950
Total tons mined...	55,587,803	61,098,092	13,445,675	13,586,864
Labor, supplies and other mining costs	1.203	1.460	3.487	3.556
Royalties and taxes†	0.825	0.927	0.808	0.832
Total cost at mines††	2.028	2.387	4.295	4.388
Total transportation and marketing....	2.391	2.677	2.505	2.639
Total cost delivered Lake Erie ports††	4.419	5.064	6.800	7.027
Non-bessemer Lake Erie value per ton base = 51.50 per cent iron.....	6.34	7.70	7.487	8.138

Note:
†Does not include Federal income taxes.
††Does not include amortization of development charges.

SUMMARY

Due to exploration and development started some time ago, iron ore for this country's iron and steel industry will soon be available in volume from foreign developments in Labrador, Liberia, and Venezuela and from large deposits of low grade taconites in Minnesota. These new sources of iron will replace a major portion of the high quality open pit ores of the Mesabi as they are slowly being depleted, and will provide much of the additional tonnage required by the industry's expansion program now underway.

We have seen that open pit mining has inherent cost advantages when compared with underground mining. The experienced mining and geological organizations of the major companies, which are exploring and developing the foreign iron ore fields, are for the present, concerned only with orebodies that can be mined by open pit methods. Ores from these new foreign sources will have to be competitive with Lake Superior ores as long as such natural lake ores are available in large quantities to steel plants located on or near the Great Lakes. Expensive railroad and dock facilities, ocean freight rates, and/or other high investment charges may place high transportation and overhead burdens on these ores. *Therefore*, in order to make them competitive at Great Lake ports, they will have to be mined and prepared at the lowest possible cost.

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DISCUSSION

PRESENTED BY

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James S. Martin: I am more familiar with the step which precedes exploration and development of a new mine, that is, prospecting and initial exploratory work, but well appreciate the point Mr. Bremner has brought out in describing the technical problems which have to be solved to actually delineate and develop these new orebodies.

While it does not come directly under the heading of exploration and development, there is another step which comes into the picture in bringing a new mine into production especially in foreign countries, and that is negotiation, namely negotiating: (1) acquisition or lease of the property, (2) conditions of exploration and development of the ore deposit and, (3) the disposition of the ore.

Negotiation does not receive a great deal of publicity yet it plays an important role in operating conditions and final cost of the ore and it will become more important in the future.

The principal negotiation phase fits into the overall scheme of developing a new mine just after the prospecting and just before the exploration and development steps. It is during this period that the basic conditions of exploration development and exploitation are formulated. However, negotiation comes into play prior to prospecting in the form of securing prospecting permits, and it also remains as an important problem even after actual exploitation commences, as evidenced by the necessity to re-negotiate lease conditions from time to time.

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TRANSFORMER OILS FOR MODERN INDUSTRY

. . . . the inhibited oil gives industry a product which will add to the safety factors and loadings in electrical transformers . . . .

▲ THE demands for electrical power since 1941 have been unprecedented in the history of the country, and, as reported by competent authorities, this demand is expected to continue at an unparalleled rate through 1960. From Electrical World's survey of the industry (May, 1952), it is shown that the probable industrial production index will reach 260 (1935-39 base period = 100), while the power output by 1960 will approximate 800,000,000,000 kwhr, compared to 371,900,000,000 kwhr for 1951. To meet this demand, the load on all electrical equipment has been, and will be materially increased, until such time as new facilities for generation and distribution come on the line. However, the economics, as well as material availability, will dictate how rapidly this expansion can take place.

Of the electrical equipment involved, transformer operation has been considerably affected by the load demands. Top oil temperatures have risen appreciably the past 10 to 15 years, creating definite problems of transformer performance, created by oil deterioration, as well as breakdown of certain other materials of construction. Since the oxidation rate of petroleum oils has been determined to double for each 10 C rise in temperature, it is entirely feasible that the life of a transformer can be approximately halved due to oil breakdown. Furthermore, certain of the varnishes and cellulosic materials are affected by oil deterioration products, as well as being thermally unstable at the higher temperatures and, as a consequence, can contribute to poor operation. Thus, it has been found that units which had performed satisfactorily for many years were suddenly failing under the increased loads. Analysis of the causes indicated that the oil, through oxidation, had created sludge. The sludge precipitated throughout the unit, lowered heat transfer rates and further raised the temperatures. As a result in many cases the solid insulating materials had failed to a point which required complete rebuilding of the unit.

In an effort to maintain satisfactory oil life, various auxiliary equipment has been incorporated in transformer design to cool the oil and to prevent the ingress of air, moisture, etc., for it is these factors of oxygen, water and heat, in addition to metal catalysis that affects the stability of petroleum oils. The methods, such as cooling coils, fans, conservators, nitrogen blankets and others, are in general use, and, therefore, will not be described herein. However, due to initial cost, weight limitations and over-all economics, this auxiliary equipment is installed only on the larger and newer power transformers. Distribution and oil-style power transformers, however, are normally operated without any protection. Consequently, it is in the latter types that the greatest benefit from the use of an oil with improved resistance to oxidation can be realized.

Accordingly, investigation was instituted in 1943 to provide a superior transformer oil that would have the basic characteristics of approved conventional oils, with the one exception of improved oxidation stability. Based on past experience with other types of inhibited oils, it was acknowledged that desired stability could be obtained by (1) base oil improvement, and (2) use of a satisfactory oxidation inhibitor. Both of these factors had been explored by major oil suppliers for many years, and the basic concepts were quite well known. However, since transformer oil was a new application introducing the possibility of electrical stress effects on the inhibited oil, an extended evaluation was necessary to obtain a base oil with maximum susceptibility for an inhibitor which would result in an oil with superior qualities. In addition, to evaluate the oil properly, bench test methods had to be developed which would simulate transformer operating conditions. Various methods for testing inhibited oils are now available and are covered in publications of the American Society for Testing Materials.[1]*

In general, naphthenic-type crudes from either Gulf or West Coast fields (because of natural low pour) are used in the manufacture of conventional transformer oils. Inhibited oils can also be produced from the same crudes, but to obtain the required inhibitor response, the base oil is further treated by special methods since it was determined that not all oils would have the same inhibitor response. Figure 1 indicates the stability of representative samples of commercially available transformer oils and an inhibited oil base stock tested in a

*Numbers refer to Bibliography at end of paper.

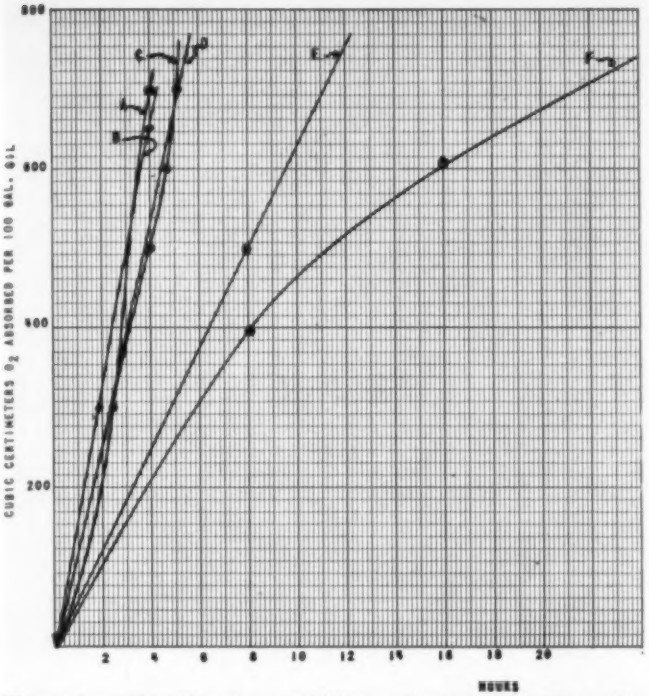
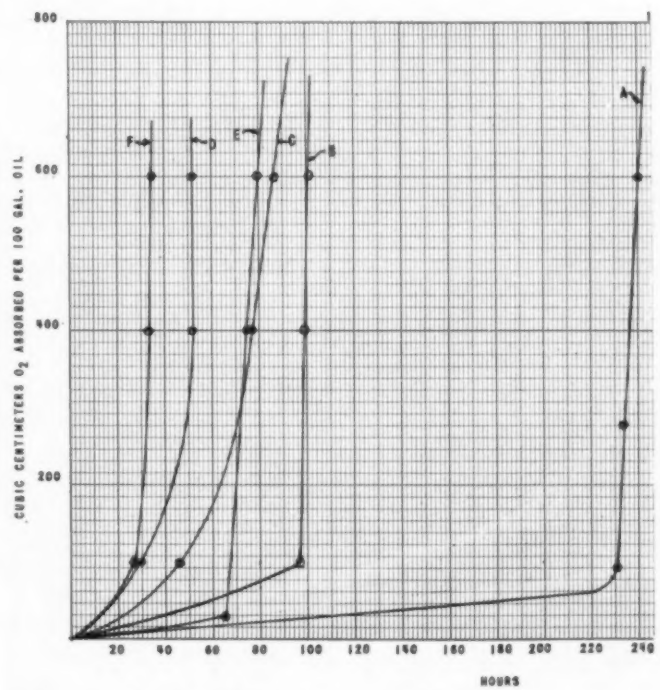


Figure 1 — Results for stability of representative oils tested in a modified Dornte oxidation test at 250 F with iron and copper catalysts. Curve marked with letter "A" is for inhibited oil base stock and curves "B" to "F" cover conventional oils.

modified Dornte oxidation apparatus at 250 F. These same oils were then blended at the prescribed level with an approved phenolic-type oxidation inhibitor and the test repeated (Figure 2).

It is evident that conventional oils may possibly have a life greater than an inhibited oil base stock, but the life will vary greatly, depending upon the degree of refining. However, on inhibition, the results are quite unpredictable. For instance, oil F in Figure 1 provided the longest life, but the same oil in Figure 2 did not show any beneficial effect from the inhibitor. Conversely, oil A, similar to oils B, C and D in Figure 1, had a 50-fold increase on inhibition in Figure 2.

Figure 2 — These curves are for tests similar to those in Figure 1 except that oils were blended with 3 per cent W oxidation inhibitor.



Thus, a base oil cannot be over- or under-refined, but only to a desired predetermined point for maximum inhibitor response. Nor, as has been stated, is the oil drastically treated to remove certain harmful sulphurous or other undesirable constituents. Sulphur content of various oils is shown in Table I.

TABLE I

	Per cent sulphur
Inhibited oil — (West Coast naphthenic)	0.02
Conventional oil —	
Gulf Coast naphthenic	0.0
Gulf Coast naphthenic	0.05
Gulf Coast naphthenic	0.075

Additional laboratory corrosion tests have not indicated any greater activity in this respect for the inhibited than for the conventional oil. In general, reputable manufacturers of inhibited oils exercise meticulous care in the selection and refining of base stocks so that optimum results are obtained. The inhibitor selected must be one that can be added in small concentrations, will be thermally stable, have no effect on the physical or electrical properties of the oil, or the other transformer components whose chemical structure is akin to that of the oil, is relatively insoluble in water, be unaffected by sunlight, and not be removed by ordinary filtration at normal temperatures.

Final selection of the inhibitor resulted in the use of a phenolic-type oxidation inhibitor providing the desired aforementioned characteristics. Since then, this type has been generally approved by various manufacturers and is widely used throughout industry.

Addition of the inhibitor to a selected base stock shows no effect on the physical properties of the oil. See Table II.

TABLE II

Properties	Base oil	Base oil plus inhibitor
Specific gravity	0.8665	0.8665
Neutralization value	0.0	0.0
Viscosity, SSU @ 100 F	60.4	60.4
Pour point, F	—70	—70
Color, union	1—	1—
Dielectric strength, kv	33	33
Mineral acids	None	None
Free and corrosive sulphur	None	None
BSI sludge test, per cent sludge	0.3	0.0

One of the oxidation tests utilized was based on a modified Dornte oxygen absorption method with iron and copper catalysts, and run at 250 F. The test is run until approximately 1000 cc of pure oxygen is absorbed by 100 gm of the oil. The time required for each 100 cc of oxygen to be absorbed is noted. As 650 cc oxygen absorbed is approximately equal to a neutralization value of 1.0, this point is used for comparative test purposes. The neutralization value of 1.0 had been found

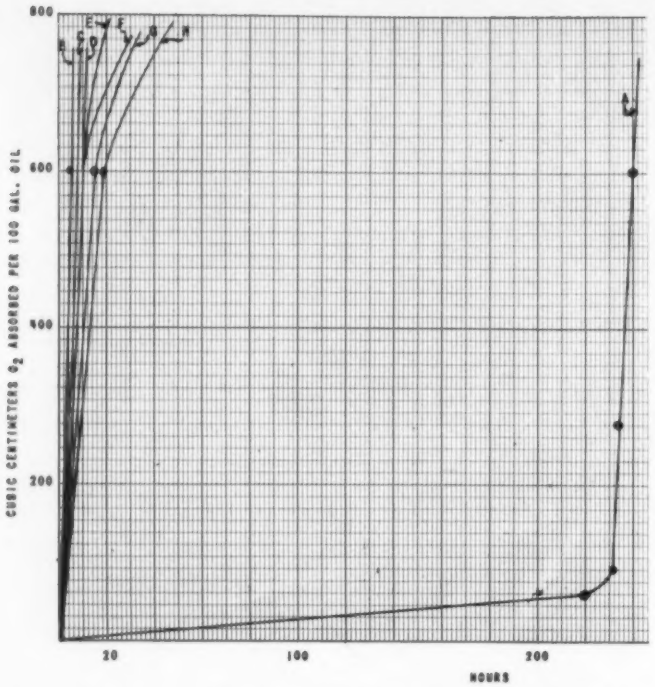


Figure 3 — Curves show evaluation of conventional oils and inhibited product by modified Dornte test. Curve "A" is for inhibited oil and curves "B" to "H" are for conventional oils.

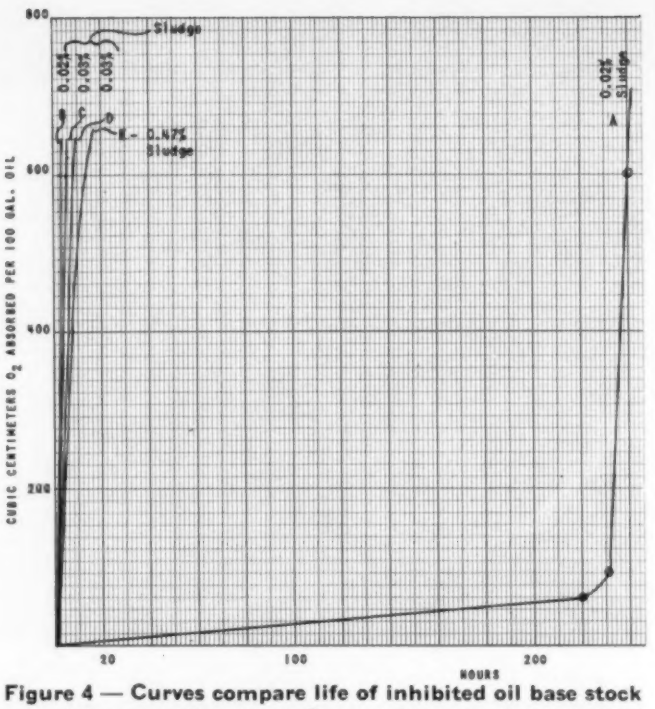


Figure 4 — Curves compare life of inhibited oil base stock with conventional oil. Curve "A" is for inhibited oil and Curve "B" is for inhibited oil base stock. Curves "C," "D" and "E" are for conventional oil. All results are from the Dornte test.

to be an average figure used by the utilities for either changing or reclaiming oil. However, many operators will use a lower figure, depending upon the maintenance procedures set up for their systems.

Evaluation, based on this test, of conventional oils and the inhibited product is shown in Figure 3. Stability of the oils varies through a considerable range, but it will be noted that the conventional products will absorb oxygen almost immediately, while the inhibited oil has an extended induction period (point at which oxygen is rapidly absorbed) before oxidation occurs. The difference in stability of the conventional oils has been indicated to be caused by either natural-occurring inhibitors or by the deposition of sludge on the catalyst coils, thereby reducing the activity and increasing oxygen absorption time.

The life of the inhibited oil base stock was also compared to the life of conventional oil to ascertain whether or not oil deterioration, after inhibitor depletion, proceeded at a greater or lesser rate. This work is shown in Figure 4. Results show that the two conventional oils and the inhibited oil base stock are within reproducible

TABLE III

Temperature and Analytical Data on Inhibited and Conventional Oils from Test Transformers

Time in Transformer, days	Inhibited oil						Conventional oil					
	Top oil temperature, C	Copper coil temperature, C	Iron temperature, C	Acid No., mg KOH/g	Color (Union)	Sludge, per cent (ASTM D670-42T)	Top oil temperature, C	Copper coil temperature, C	Iron temperature, C	Acid No., mg KOH/g	Color (Union)	Sludge, per cent (ASTM D670-42T)
0	76	82	78	0.0(0)	1	0.0(0)	74	85	79	0.0(0)	1	0.0(0)
18	75	81	79	0.0(6)	1	....	74	84	79	0.0(7)	1½	....
64*	91	96	93	.....	.....	....	88	101	93	.....	.....	....
77	91	97	93	0.1(1)	1½	....	88	101	93	0.0(6)	3—	....
108	93	99	95	0.1(1)	2	0.0(0)	90	105	97	0.1(5)	3	0.0(3)
140	93	99	96	0.1(1)	2	....	91	105	98	0.3(1)	3½	....
161	92	97	94	0.1(1)	2½	0.0(0)	91	105	98	0.3(2)	4	0.0(3)
200	90	97	97	0.1(1)	2½	0.0(1)	90	107	97	0.4(0)	4½	....
226	91	97	97	0.1(1)	2½	....	91	106	98	0.3(6)	4½	....
253	90	96	96	0.1(1)	2½	....	91	107	99	0.4(5)	5	....
281	90	96	96	0.1(1)	2½	....	90	109	100	0.4(5)	5	....
317	91	97	96	.....	.....	.....	91	108	100	.....	.....	.....
339	91	97	97	0.0(9)	2½	0.0(1)	92	111	102	0.4(5)	5	0.0(5)
365**	91	97	97	0.1(1)	3—	0.0(6)	92	111	102	0.5(0)	6—	0.1(3)

*Temperature increased to accelerate deterioration.
**Final samples contain full amount of sludge.

TABLE IV

Electrical Properties of Inhibited and Conventional Oils from Test Transformers

Measurements at 60 C

Sample No.	Time in Traysformer, (days)	Inhibited oil			Conventional oil		
		Power factor 150 cycles, per cent ±0.08	D-c resistivity ohm/cm	Dielectric constant 150 cycles	Power factor 150 cycles, per cent ±0.08	D-c resistivity ohm/cm	Dielectric constant 150 cycles
Start	0	0.08	1000×10^{12}	2.15	0.08	$>1000 \times 10^{12}$	.....
1	18	.....	.....	.....	.....	.....	.....
3	57	.....	.....	.....	.....	.....	.....
4	77	.....	.....	.....	0.87	0.56×10^{12}	.....
5	108	.....	.....	.....	.....	.....	.....
6	119	.....	.....	.....	0.64	0.85×10^{12}	2.18
7	126	.....	.....	.....	0.57	0.88×10^{12}	.....
9	161	0.57	1.6×10^{12}	2.12	.....	.....	.....
10	177	.....	.....	.....	.....	.....	.....
11	200	0.48	2.1×10^{12}	.....	.....	.....	.....
12	226	0.40	2.4×10^{12}	2.12	0.82	0.69×10^{12}	2.18
13	253	.....	.....	.....	.....	.....	.....
14	281	.....	.....	.....	.....	.....	.....
16	339	0.20	2.6×10^{12}	2.13	.....	.....	.....
Final	365	0.20	2.1×10^{12}	.....	0.74	0.71×10^{12}	.....

limits of the test, while one oil has a somewhat longer life. As pointed out previously, this latter oil threw down sludge, thereby increasing absorption time.

Additional chemical and physical tests were made to determine the performance of the inhibited oil, and also the effect of the inhibitor, i.e., effect of dissolved insulating varnishes on oil, increase of power factor and d-c resistancy decrease during oil oxidation, etc. In all cases, either no change was found, or a marked improvement in over-all operation was noted.(1)

With the satisfactory completion of the aforementioned bench tests, a series of tests were instituted to determine actual performance of the inhibited oil in a distribution transformer. Accordingly, two kva transformers, one containing inhibited oil, the other conventional oil, were coupled back to back in accordance with the American Standard Association recommendation for temperature tests. The windings carried normal voltages, but the current was maintained at 175 to 200 per cent of rated capacity, with the result that the top oil temperature was held at 90 C. To permit free access of air, the covers were loosely placed on the units. The tests were continued for one year, which, at the 90 C level, were approximated to equal 10 years' normal operation. Results are shown in Tables III and IV.

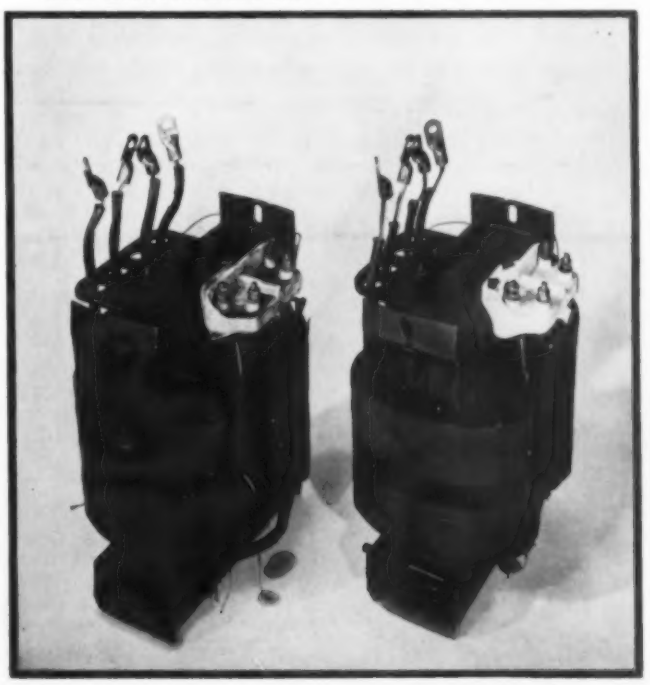
On completion of the one-year test, the units were disassembled and closely inspected. The unit containing conventional oil had considerable sludge and varnish deposition on the core and coils, which had decreased heat transfer rates, thereby increasing the over-all temperature, and, hence, accelerating the oxidation reaction (Figure 5). The core and coils of the unit with inhibited oil were very lightly coated with a thin varnish-like sludge. It was determined that this sludge was caused by precipitation of the insulating varnish which had been solutized by the oil. Actually, no oxidation had occurred, for after 77 days until the end of the test, no neutralization number rise was noted.

Since the laboratory results showed great promise for the inhibited oil, the product was submitted to various utilities for their evaluation. A wide variety of tests was run, both in laboratories and in the field, to determine the relative performance of conventional and inhibited oils.

One of the most active participants in this investigation was a large Midwestern utility, who, over the years has expended a considerable amount of time and money in an extensive testing program to properly assess the oils.(2) One of the series of tests utilized distribution-type transformers, which were free-breathing and relatively unprotected. Another series now under way uses the same type transformers, but they are protected either by a nitrogen blanket or a conservator.

The free-breathing units were two new 15-kva trans-

Figure 5 — Transformer cores are shown after one year's service at 90 C oil temperature. On left is shown core used with conventional oil and on right is shown core used with inhibited oil.



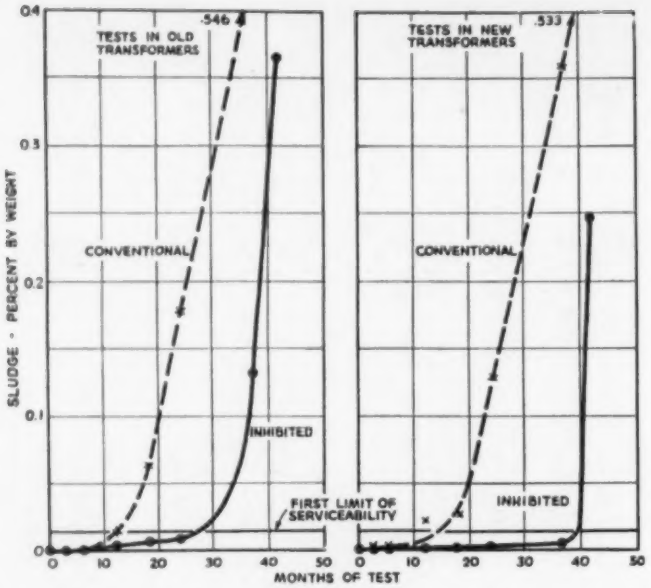


Figure 6 — Curves give sludge content of oil in first series of transformer tests. Sludge was determined in accordance with ASTM method D 670-42T after sample removed from transformer was permitted to stand in dark overnight.

formers and two 22-year old, 10-kva units, which were reconditioned by established methods. Conventional oil was placed in one 10 and one 15-kva units, and inhibited oil in each of the others. It was considered this comparative test would then evaluate the performance of the oils for: (1) new unit operation where air would be in free contact with the oil, and (2) as a replacement charge in old units where residual sludge could possibly affect the life of the oil.

The four transformers were installed in a thermostatically controlled insulated box, and top oil temperatures were obtained by operating each pair of units in series with short-circuited secondaries. From the start of the test to the latter part of 1946, the top oil temperature was held continuously at 90 C, and from then until late 1947, a 64-hour-per-week cooling period was introduced to promote a breathing action. The cooling period until the end of the test was then lowered to 16 hours per week. Total elapsed time was 42 months. Periodic samples were taken, and the results tabulated as shown in Figures 6, 7 and 8. The units were then torn down and inspected. See Figures 9 and 10. A heat run was made of the two 15-kva units to determine actual temperature raise and is tabulated in Table V.

The increase for the unit with inhibited oil is comparable to those found in new units, while the unit with conventional oil had approximately double the rise of the former. Therefore, it was conclusively demonstrated that, by preventing the formation and deposition of sludge, overloads could be carried without experiencing abnormal temperatures. On the basis of the test results, it was concluded that the service life of inhibited oil was double that of conventional oil in used transformers, while the factor was increased to 3 to 1 in new transformers.

Another utility undertook a long-term evaluation of the inhibited product in 500-kva station transformers. These units had operated in excess of 15 years without overhaul. Cleaning consisted of draining the old oil and flushing with filtered used oil, and then new oil. A charge of inhibited oil and conventional oil was then placed in each unit. Analysis of the two oils was as given in Table VI.

A preliminary check of the oils indicates that contamination by used oxidized oil has affected the expected service life. However, based on past experience from other field tests, the degradation should level off and the test values remain comparatively constant until the end of the induction period. This particular test will continue for an indefinite period with samples taken at yearly intervals.

A large number of other test programs is presently under way, but it will be a considerable length of time before the final results are available. Suffice to say, the performance of inhibited oil in all cases has been more than satisfactory.

Figure 7 — Neutralization number of oil in first series of transformer test in accordance with ASTM D-663-46T.

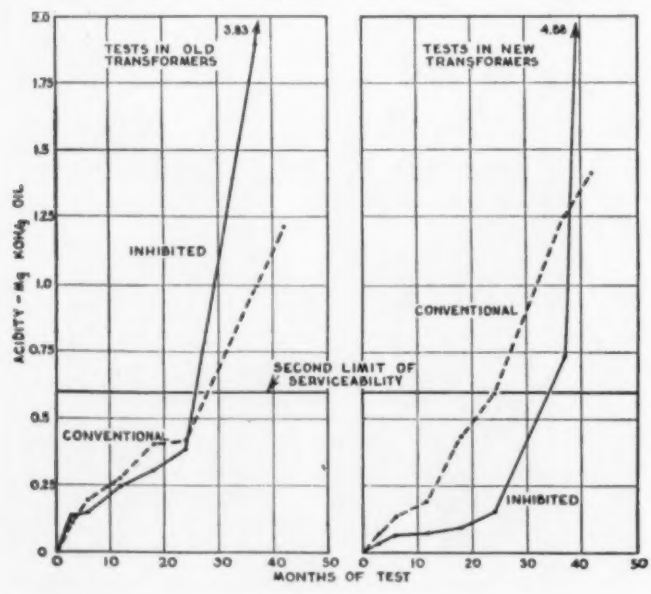
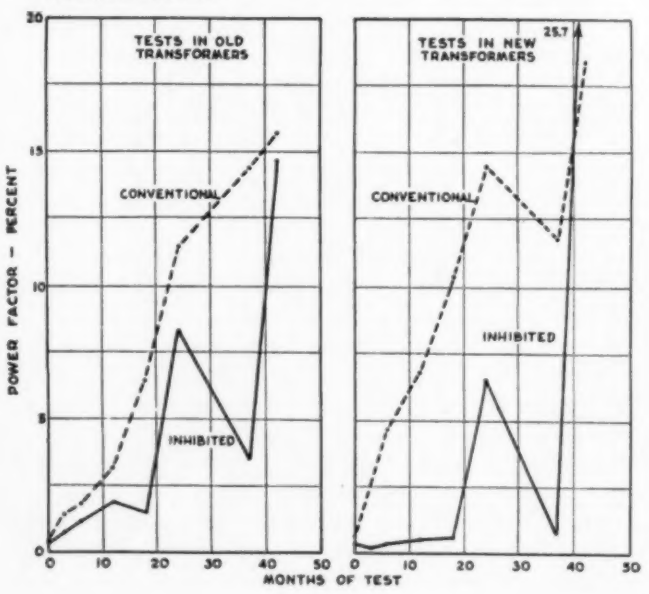


Figure 8 — Power factor at 100 C of oil in first series of transformer tests determined in accordance with ASTM D-924-49.



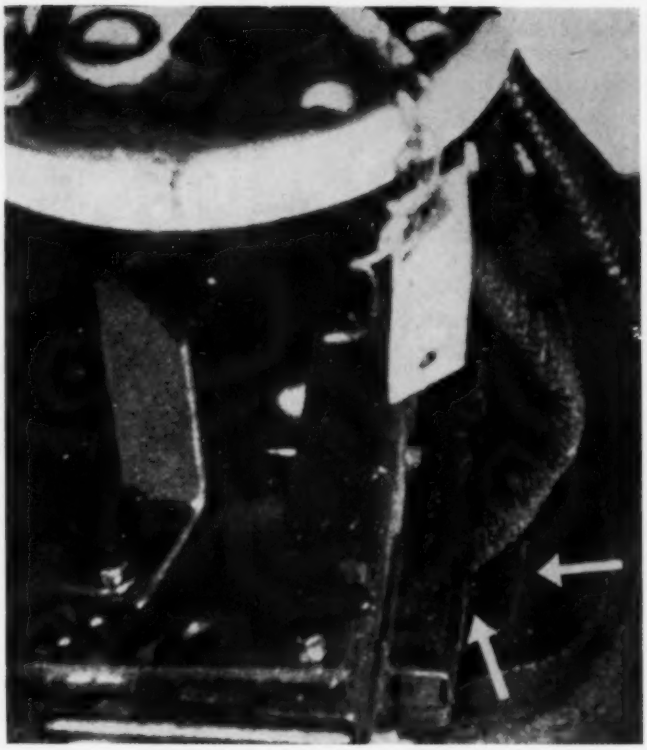


Figure 9 — New 15-kva distribution transformer is shown after 42 months of aging tests with inhibited oil. Arrows show free oil channels.

Figure 10 — New 15-kva distribution transformer is shown after 42 months of aging tests with conventional oil. Arrows show clogged oil channels.

With the introduction of inhibited oil, the utility operator quite naturally was interested in the various factors arising from its use, i.e., blending with new or used conventional oil, performance in switchgear, cost, etc.

Again using the modified Dornte apparatus, various blends of inhibited and conventional oil were tested (Figure 11). It will be noted that the stability of the blends will not be less than the poorest oil, nor will it be better than the most stable one. Stability in all cases is somewhere intermediate of the two oils, but not as a linear function.

TABLE V[2]

Heat Run on 15-Kva Unprotected Transformers After Completion of 42 Months of Aging Tests*

	Temperature rise**	
	Inhibited oil A	Conventional oil
High voltage winding (avg)***	50	113
Low voltage winding (avg)***	47	90
Top oil	39	46

*Transformers were new at start of aging tests. These measurements were obtained in accordance with standard temperature tests by opposition method, ASA C57.22.
**Ambient in tests was 22 or 23 C; allowable maximum ambient according to AIEE Standards is 40 C.
***Maximum rise permitted by AIEE Standards is 55 C for new transformers.

The effect of oxidized oil on the stability of new oil is shown in Figure 12. This is a most important factor when replacing oil in used transformers. To obtain the maximum benefit from a new oil, residual sludges should be thoroughly removed before charging the oil. During the early stages of operation, a careful check of oil condition is recommended, since it has been found that new oil will solutize or "leach out" degradation products that were not removed at time of cleaning.

The application of inhibited oil in switchgear has been of considerable concern to operators because of the possibility of inhibitor decomposition under electrical arc. This point has been extensively investigated in the laboratory and in the field, and in no case has any deleterious effect been noted. On the contrary, some improvement has been seen in the rate of carbon settling. This has been explained on the basis that the more stable oil will permit carbon precipitation since incipient oxidation products are not present. On the other hand, oxidized oils tend to form slight emulsions which can hold the carbon in suspension, and, therefore, permit tracking and possible failure. Certain manufacturers have recently completed their investigations and inhibited oils are now approved for switchgear. On the basis of this approval, inhibited oil can be used as a replacement for conventional oil in all applications where the latter was used.

The adoption of the inhibited oil has not created any abnormal problems of handling, storage or operation. The companies that have replaced conventional oil by

TABLE VI

Long Term Test 500-Kva Transformers

	Inhibited oil		Conventional oil	
	1 Week	2 Years	1 Week	2 Years
Color, ASTM	2½	2½	2½	3
Appearance	Clear	Clear	Clear	Clear
Neutralization value TAN-C	0.04	0.10	0.05	0.12
Interfacial tension, dynes	45	26.7	.....	28.2
Dielectric strength, kv	26	23	.....	14
Dornte oxidation stability @ 250 F (hr)	150+	44	5	.....

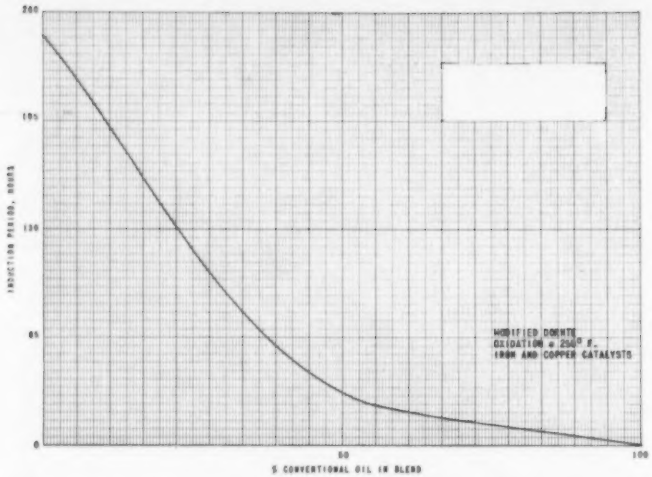


Figure 11 — Curve shows effect of dilution of conventional oil upon stability of inhibited oil as given by the modified Dornte test.

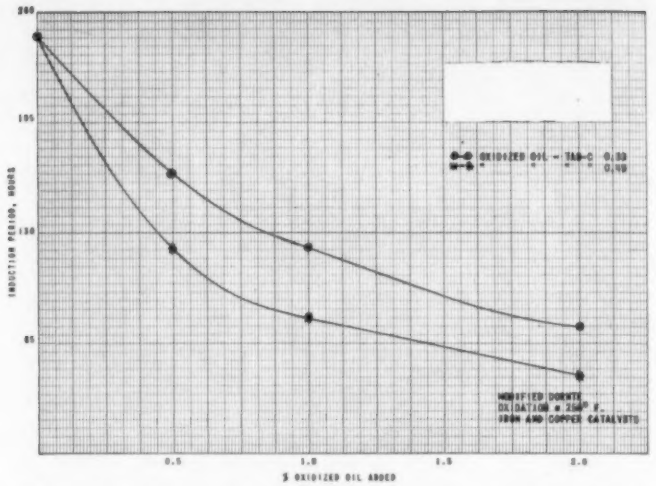


Figure 12 — Curves give effect of contamination by oxidized oil upon stability of inhibited oil as given by the modified Dornte oxidation test.

it, did so in a progressive manner, so that normal procedures of storage and handling were not disrupted. Blending with other oils has been done, although (Figure 11) the maximum advantages of the inhibited oil are impaired. The same precautions necessary to keep an oil clean and dry also apply to this product.

Operation and maintenance of equipment containing inhibited oil has more than justified the time and cost in changing oil. Many of the so-called "tough job" applications, where frequent oil maintenance or actual repair was necessary, have given greatly improved performance after the oil was replaced. For instance, underground transformers that usually operate in high ambient temperature areas have shown marked results when filled with inhibited oil. Units that operated less than one year with conventional oil have gone over two years without an oil change. Oil-filled bushings that formerly became coated with lacquer-like deposits have operated free of all degradation products for extended periods. As a result of a large number of satisfactory field service reports, it appears that many of the problems formerly faced by industry can be greatly reduced by the use of an inhibited oil.

Operating costs today are at an all-time high, and industry, therefore, is required to practice economy wherever possible. Thus, if maintenance costs can be materially lowered by the replacement of a component in a unit that is a potential source of trouble, the increased cost of the new material is justifiable. The price of an inhibited oil is indicated to be 5 to 8 cents higher than conventional oil. However, though this differential may appear to be considerable, it loses significance if a service or overhaul period is greatly extended or possibly eliminated. It has been stated by a competent operator that only a 9 to 10-day extension in transformer life would more than repay the initial cost of new oil. Hence, when considering oil replacement, the over-all economics, based on the expected end results, must be thoroughly evaluated.

Briefly, the foregoing discussion of inhibited oil may be summarized by stating that there is now available to industry a product which will provide added safety factors in electrical equipment upon which industrial production is so dependent.

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DISCUSSION

PRESENTED BY

ERIC L. ANDERSON, Electrical Superintendent, Bethlehem Steel Co., Johnstown, Pa.

A. S. MORROW, Lubricants Department, Shell Oil Co., New York, N. Y.

GEORGE H. SCHAEFFER, JR., Electrical Superintendent, Carpenter Steel Co., Reading, Pa.

D. C. McCRADY, Electrical Engineer, Steel Co. of Canada, Ltd., Hamilton, Ontario, Canada

EDWARD E. BAUER, Assistant Manager Sales-Power, Power Transformer Dept., General Electric Co., Pittsfield, Mass.

Eric L. Anderson: I would like to ask one or two questions. We have in our plant transformers that have been in service for a number of years in which the neutralization number will run from 1½ to 2 and in some cases possibly higher. Can inhibited oils be applied to such transformer installations? Is there any special preparation or cleaning of the transformer required before the inhibited oil is applied? You mentioned that the type of inhibited oil to be used was dependent on the type of varnish used on varnish impregnated transformers. How do we determine what type to use?

A. S. Morrow: Mr. Anderson inquired about the application of inhibited oil in old units. I think, as we pointed out, that the presence of old deteriorated oil will definitely reduce the life of the new inhibited oil. Furthermore, I think the application of inhibited oil to industry will certainly depend on the economics involved and the desires of the management.

If you are going to buy insurance, you can buy

$10,000 worth or you can buy $100,000 worth, depending on how you feel about it and how much money you have. The same applies to the use of inhibited oil in used transformers. The cleaner the unit, at additional cost, the greater will be the expected life of the new oil. The cleaning of transformers is a troublesome and costly job. It has been done. We have done it in the field by taking units off the line, draining the old oil, shoveling out the sludge and then flushing down with filtered used oil using a high pressure pump and jet, draining it, then flushing down with new oil, draining this and then charging the new inhibited oil. We found at the end of a two year period in a comparative test in 500-kva units that the life of the conventional oil, which was approximately five hours originally by the Dornte, showed it has been reduced to nil. In other words, we could not get a time factor value by the test.

The inhibited oil, on the other hand when new, had a life in excess of 150 hours and now had been reduced to approximately 45 hours, showing that the oil had been effected by the residual deterioration products that were present in those units.

Another method, if you have the means and the time and the money, is to remove the core completely, and immediately clean it manually or possibly wash it down with some type of non-aromatic solvent. We do not recommend washing with aromatic solvents for the simple reason they will solutize many of the varnishes now in use. They also have a residual effect on the stability of the oil.

George H. Schaeffer, Jr.: Can inhibited oil be applied to oil circuit breakers or contactors?

The particular question I have in mind is this: We have oil circuit breakers which are used for arc furnace duty. These circuit breakers operate anywhere from 100 to 150 times a day, and in about three or four weeks the oil must be changed because it has become highly carbonized. Can inhibited oil be applied to these breakers and, if so, would it reduce the number of oil changes now required?

A. S. Morrow: Mr. Schaeffer inquired about inhibited oil and oil circuit breakers and what to do about the cracking of the oil. If the oil industry could obtain an inhibitor to prevent cracking, we could eliminate a great deal of equipment and headaches. In our own industry, that is one thing we cannot prevent. When oil is subjected to 4000 or 5000 or possibly 6000 F, there is nothing you can do. It will crack. Regardless of the type of inhibitor used, they are non-effective in this case. The oxidation inhibitor is not good for that. It will not prevent cracking. However, we have indications that the oxidation inhibitor in inhibited oil by reducing oxidation has some effect on allowing the carbon that is formed to precipitate to the bottom of the casing. On the other hand, there are some people that say they do not want the carbon to precipitate, they would rather keep it in suspension. That is a matter of personal preference.

I think that at the present time, we have found that the addition of the inhibitor has not caused any deleterious effect on the oil in circuit breakers. In fact, all the major companies now state that the inhibited oil can be used in switch gear.

D. C. McCrady: There is one question which I would like to ask, and that is in connection with filtering transformer oils. There is a type of equipment on the market for taking out what they call the low molecular weight acids. Now, after treating transformer oil with that method, would the use of inhibitors thereafter make the transformer oil less subject to future oxidization?

A. S. Morrow: Many types of filtration equipment are used today in the industry, depending on what you want to do to the oil. There is one for taking out nuts and bolts; one for removing the water, and then there are those that by absorption claim they are actually re-refining the oil. There are centrifuges, blotter presses, thermosyphons, various types of earths, activated carbon and chemical means such as phosphate, sulphuric acid, caustic and the rest. It appears that filtration through an activated earth is one of the better ways to reclaim a transformer oil; however, in doing so, you may reduce the presence of organic acids, say, from an acid value of one or one and a half down to 0.5, 0.25 or thereabouts. Also you must realize that many of the natural inhibitors that have been originally present in the oil have thereby been likewise removed, so that on re-refining or reclamation, the stability of that oil is never quite as good as it was initially. We have found that reclamation of used transformer inhibited with a prescribed quantity of the inhibitor resulted in a Dornte life of approximately the same as when the oil was new. As can be seen in the illustrations in the paper, some of the new conventional oils had a life of approximately five hours. By the Dornte test we have found that those oils when they were reclaimed and blended with 0.3 per cent of inhibitor again came out with about five and a half to six hours' life. So it requires evaluation studies, an economic survey, a decision on the amount of money you want to spend, what equipment is available, and what you expect after you are finished with your reclamation and inhibition, to honestly evaluate new inhibited oils and reclaimed, inhibited conventional oils.

Edward E. Bauer: I would like to say that at Pittsfield, Mass. we have converted over to the use of inhibited oil on all distribution type of transformers. Those are the outdoor pole type transformers. In the power transformer department, we have not converted to inhibited oils primarily because of the lack of customer demand.

The other material that should be considered when thinking of a premium type product is an askarel type of liquid insulation.

My point is this: There are applications where an inhibited oil is a perfect solution; and there are others where an ordinary oil will do just as well, and there are other applications where an askarel is desirable.

A. S. Morrow: Mr. Bauer gave a general dissertation on the application of inhibited oils. I quite agree with him. There are also applications where the askarels are the only answer; due to underwriters, fire risk, etc., you must have oil of low fireability for that application. In large units, they are protected with various types of conservatives, etc.

There is still a question of the value of inhibited oil. Although it has been indicated in tests that are under way that there is a possibility that the inhibitor oil will have a place in that application, likewise, we do not know, we have to wait and see how the answers come out by the basic application for the inhibited oils in the older style units, which are free-breathing and heavily overloaded.

PROPERTIES AND USES OF SEMISILICA BRICK

By G. BICKLEY REMMEY
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. . . . standard short duration refractory tests do not always bring out the advantages inherent in semisilica brick . . . .

▲ AFTER the First World War, twenty-three brick companies manufacturing semisilica brick existed in New Jersey. Some of them were making brick with a composition very similar to the present semisilica brick and some differed or possibly varied enough to give excessive expansion, thermal spalling or shrinkage. They were all made by the soft mud process which produced considerable variations in symmetry. In addition to this, most New Jersey clay deposits vary a great deal in shrinkage or silica content, which made the brick of this period quite irregular in size.

In New Jersey and nearby areas, such as Philadelphia and Bethlehem, these brick were used quite generally before the First World War. Slackened business activity after the war, however, caused the larger firebrick companies in central Pennsylvania to realize this eastern market was fertile soil for their product: (1) Their clays varied much less in shrinkage. (2) Manufacturing could be done by either the stiff-mud or the dry press method which (especially in the case of the dry press method) produced brick more uniform in size and of a much better appearance than the New Jersey brick. (3) Ceramic engineers and refractory test laboratories were beginning to function. Note the panel test was not yet developed. The results of *water dip test* which was used put semisilica brick at the bottom of the list. Certainly if this were the complete and true industry story, these siliceous clay brick from New Jersey would be out of existence today. Many of the producers did dissolve during the "twenties." Of the twenty-three manufacturers originally mentioned, all but four are out of existence; two of these still produce semisilica brick. The results of this early research and testing all showed the advantages of high alumina and the disadvantage of high silica clay refractories. The latter group, of course, included just about all the clay firebrick made in New Jersey. See Table I for comparative results of high heat duty brick (Pa. type) and semisilica brick (N. J. type).

Table I

Results of ASTM Standard Load Tests on High Heat Duty and Semisilica Brick

	High heat duty	Semisilica
Fusion test P.C.E.	32 (3100 F)	28 (2950 F)
Reheat 2900 F, per cent	0.2	slumps
Load test at 2642 F, per cent	4-6*	less than 4
Loss in panel spall test, per cent	5-14	4-15
Porosity, per cent	16	28
Al_2O_3 content, per cent	37	20

*This range is for the most load resistant brands.

The flint clay brick from Central Pennsylvania began to invade the New Jersey area with success, but they ran into one form of resistance. In certain industrial applications, things worked altogether different from the indications of the laboratory tests. Information from some of the first refractory engineers that the Pennsylvania flint clay brick were so superior in laboratory tests sold many potteries in New Jersey on changing from the New Jersey brick. In service, however, the flint brick would slump out of shape or spall in kilns where the New Jersey brick lasted many times longer. The same difference was apparent in some steel industry furnaces. In this decade there were arguments and hard feelings between some of the New Jersey manufacturers and the larger producers of flint clay brick, but no enlightening investigation was made. Most engineers and producers of other refractories, it seemed, had a tendency to discount the claims made for the New Jersey brick.

We drew our conclusions from what we observed in customers' furnaces. By the late twenties we learned

that engineers will not give credit to hearsay or performance stories if they are contradictory to what they believe to be established facts. It became apparent that if we were to spread the use of New Jersey brick we must make some scientific investigations or at least find the reasons for the above apparent contradictions.

At this time our company was not large enough to do this in the usual way of employing scientific personnel of proved ability. Our interest in convincing the industry of the economy of semisilica brick along with the interesting possibilities of special and super-refractories led us to setting up a laboratory. Soon after this, our company took the position that New Jersey brick was a different kind of refractory and possessed unique properties.

These properties are not measured by conventional methods of testing, but are consistently revealed when studies are made of semisilica's behavior in service. These properties are also very different from the clay bricks made in Pennsylvania and Missouri fields that are high in silica — sometimes called siliceous clay brick or, as named by ASTM, intermediate duty brick. To prevent confusion between these and New Jersey siliceous brick, we started to refer to our brick as semisilica. This is a fitting name because nearly half the brick consists of crystalline silica; the other half, refractory clay. Many of its properties such as analysis, reversible expansion, resistance to deformation at high temperature, etc., are between silica and clay brick. They are often used as an in-between brick where the load and temperature are too high for clay brick and spalling conditions are too severe for silica brick, providing temperature is not above 2750 F.

The two most important properties of semisilica brick are: (1) they do not fail from structural spalling, (2) their resistance to deformation under loads at high temperatures is so high that increased life runs from two to five times longer than high heat duty brick in the recommended applications.

Before we can understand the spalling behavior of semisilica brick, it is necessary to recognize the difference between thermal spalling and structural spalling. Thermal spalling is caused by the brick being subjected to thermal changes great enough to rupture it. Structural spalling is caused by a change in the brick structure brought about by additional heat treatment, slag absorption, or both. While thermal spalling is the type of spalling most commonly thought of when the word "spalling" is used without qualification, *structural spalling is by far the more common form of spalling in refractories used in the heavy industries.* A typical case of structural spalling is one in which the heated end of the brick expands from absorbing and reacting with the furnace fluxes to the point where the expanded hot end tears itself loose. (See Figure 1.) This has been known to take place in continuously operated furnaces where no temperature fluctuations were encountered. The more common type of structural spalling takes place in furnaces where the brick are exposed to moderate thermal fluctuations that cause spalling after some structural change has developed in the hot end of the brick.

Cases of structural spalling can easily be recognized by examining the spalled part of the brick. In such cases the spalled pieces have changed their structure considerably. In the case of clay brick the spalled part will be more vitrified, expanded or shrunk, and usually a darker color when compared with the cooler part of the brick which has not been subjected to the heat and slag penetration of the furnace. Another thing that helps to diagnose a structural spalling case is the time it takes place. Structural spalling will not take place soon after the new brick work is put in use because it takes time for the hot ends of the brick to undergo the structural change. After a length of time — usually two months to a year or so depending on how hard the furnace is used— the structural change develops in the ends of the brick and spalling will generally be quite rapid.

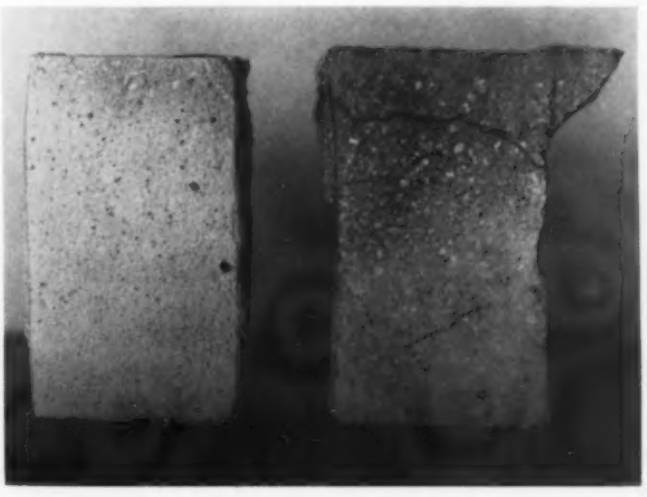
BEHAVIOR OF SEMISILICA BRICK IN ASTM PANEL SPALLING TEST

This test, used very successfully in evaluation spalling resistance in various brands of clay brick, has been tried for evaluating semisilica brick, but the results have no relationship with the performance of these brick in service. If we consider what the test does, and how clay and semisilica brick behave under these conditions, it is easily understood.

The panel spalling test consists of two parts. First, a preheat at 2912 F for twenty-four hours to develop a structural change in bricks of low resistance to structural change. No slag or fluxes are used in the test; so if the brick do not contain detrimental impurities and are properly made, they will not be seriously affected by this treatment and will show up well in the test. The second part of the test subjects the brick to ten cycles of sudden thermal changes that clay brick can stand unless they were seriously affected by the preceding heat treatment.

When semisilica refractories are put through a panel test, the preheat part of the test does not make them any more likely to spall because they have such high resistance to structural spalling. But the thermal shock

Figure 1 — Illustration of structural spalling. Left is semisilica brick and on right is high heat duty brick removed after reheat of panel spalling tests at 2912 F. Spalling of high heat duty brick is apparent. The high heat duty specimen that was used in this test is more subject to structural spalling than most high heat duty brick.



cycles in the second part of the test are severe enough to cause spalling in various amounts, giving results that would not indicate the superiority of this type brick for structural spalling resistance. The important difference between this test and the conditions semisilica brick meet in service is the thermal shocks in the second part of the test are much more severe than those occurring in furnaces where semisilica brick are recommended. Clay brick, unless they have been structurally changed in the preheat part of the test, will stand these severe thermal shocks without spalling so that the second part of the test is effective in showing which clay brick have structurally changed to a serious extent. The only effect the panel test has on semisilica brick, however, is one of thermal spalling and since this type brick is not able to stand the extremely severe thermal shocks as well as clay brick, the test gives misleading results. Semisilica brick have been tested with and without the preheat, giving results that were practically identical, showing that the preheat part of the test — designed to cause the structural change — did not have any effect on them.

While semisilica brick will not stand the extremely severe thermal shocks of the panel spall test they do stand the thermal shocks encountered in soaking pit covers. This service subjects the brick to about the most severe thermal shocks encountered in large furnaces. Many steel plants have used semisilica in covers for years and their use in this application is spreading. The speaker has witnessed on two different occasions in two separate plants where a cover has been lined half with high heat duty clay brick and half with semisilica brick. After four to five months service, the half lined with clay brick had spalled seriously while the semisilica brick showed no spalling and remained in good condition when the clay brick had to be replaced. We also have a report on a similar test where semisilica brick were compared with a super duty brick in which the results were the same after a little longer time in service.

In conclusion, semisilica brick are superior to high heat duty clay brick with respect to structural spalling and inferior to them with respect to thermal spalling. You can see now why it is so important to recognize the difference between thermal and structural spalling before it would be possible to select the correct brick for an application.

STRUCTURAL SPALLING THEORY

Now let us consider the difference in the behavior of these two types of brick when they are placed in a furnace fired with one of the low priced fuels, such as crude oil or coal. When high heat duty, super-duty or high alumina brick are used in such furnaces, the fluxing constituents resulting from the ash in the oil or coal, or from the materials being heat treated, contact the surface of the brick. Even if these fluxing constituents do not contact the brick directly, they reach the surface of the brick by means of fly ash or volatilization. These fluxing elements react with the surface of the brick to form low melting glass or slag, which in turn is drawn into the clay brick to a depth depending on the temperature gradient through the wall and the melting

Figure 2 — High heat duty clay brick above semisilica brick after 50 runs in periodic kiln firing firebrick. Test bricks were built in kiln wall. Note how the pick-up of impurities from the furnace has caused a glaze on the semisilica brick in the lower part of the picture, while the high heat duty clay brick in the upper part, remain dry because the impurities have soaked into them.

point of these glasses. After a significant amount of this glass is absorbed by the brick's hot end, the original composition is naturally altered. It has a lower fusion point, different thermal expansion, specific gravity and porosity. In short, the hot end has changed both its composition and structure. This condition takes place at any temperature above the melting point of the most easily fused combination of fluxing elements that accumulate in the furnace. This temperature is quite low when compared to the high temperatures used in the panel spalling test. As this change in structure of the hot end of the brick progresses, it will reach a point where the moderate thermal fluctuations of the furnace are severe enough to cause the altered or structurally changed hot end of the brick to spall.

When semisilica brick are used in such a furnace, they react entirely different. In their case the slag or fluxes in the furnace would contact the brick also. But, surprising as it may seem, the resulting glasses do not soak into semisilica brick. It accumulates on the surface and reacts with the hot face forming a glazed surface. As additional amounts of fluxing elements are deposited on the hot surface, a more fluid slag is formed that runs down over the brick's surface. Of course, this slag takes with it some of the brick which is dissolved at this hot surface only. See Figure 2. The semisilica brick wall or roof wears back evenly without spalling. Because the fluxing constituents do not penetrate the end of semisilica brick, they do not undergo a structural change that results in spalling. Thus, unless the furnace has unusually severe thermal shock — such as only encountered in small furnaces that are heated and cooled daily — semisilica brick do not spall but gradually wear back from slag erosion, giving unusually long life in the process.

The only change that takes place in semisilica brick on heating is the conversion of some of its quartz particles to cristobalite and tridymite. This does not change materially their resistance to spalling. The

porous structure of the brick tends to absorb the expansion, without rupture, as it slowly develops. This phenomenon is peculiar to semisilica brick and is described in previous papers as follows: "Semisilica Refractories Lessen Furnace Structural Failures," by G. B. Remmey, Steel Magazine, November 27, 1950. "Some Properties of Semisilica Brick," by G. B. Remmey, Journal of the American Ceramic Society, Vol. 22, No. 6, June, 1939.

PROTECTIVE GLAZE THEORY

This, of course, brings up the question as to why these fluxes or slags do not soak into the semisilica brick as they do in the bricks containing higher amounts of alumina. We have a theory to explain this that checks well with present ceramic technology. This theory attributes this quality to the high silica to alumina ratio in semisilica brick in combination with relatively low impurities, and a texture that is typical of this class of refractory. The composition of these brick is so close to the alumina silica eutectic that only a small pick-up of fluxes is necessary to fuse the surface. In other words, the glass resulting from the fluxing constituents that have contacted the surface of the brick is composed essentially of the brick plus just enough flux to make it fuse into a glass. Because of the small amount of flux required to produce this glass, it is composed largely of the siliceous brick, which gives the glass also a high silica content.

Like most glasses that are high in silica, this glass has a high viscosity — too high to be absorbed by the small pores in the body of the brick — thus it forms a protective glaze over the brick surface. As more fluxing constituents from the furnace are deposited on this protective glaze, they react with it slowly because of its high viscosity and low porosity producing a more fluid glass that runs down over the surface of the protective coating. See Figures 3 and 4. In Figure 3, the white or light colored protective coating can be seen easily on the surface of the semisilica brick and the darker color, or fluid slag, partly adhering to it.

Figure 3 — Semisilica brick removed from kiln wall after a long campaign and cut perpendicular to the hot face. Note how the slag is confined to the outer surface. The white protective layer may be seen between the dark colored outer slag and the brick. The protective layer is exposed on the top edge where the outer layer of slag was chipped away.

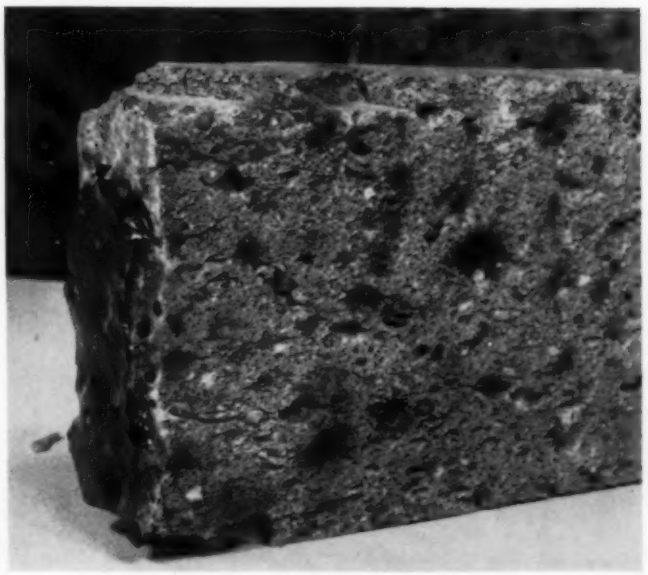


Figure 4 — High heat duty clay brick removed from zinc smelting furnace show case of structural spalling caused by combination of slag absorption and thermal shock.

Petrographic examinations have shown that there is a sharp difference between the protective coating and the outer more fluid slag, with a much higher index of refraction for the outer slag than for the protective coating. The index of refraction for the protective coating is close enough to that of fused quartz to account for the explanation that its viscosity is too high to be absorbed by the brick. The fact that this glass does not penetrate the brick can be established by visual inspection as well as by more thorough examinations with the microscope. The higher iron content of the outer more fluid slag also confirms the fact that there are two definite layers of slag on the surface of semisilica brick, with the underneath one possessing a much more refractory composition, and thus acting as a protective coating. The fact that these two layers of slag exist can also be demonstrated by tapping the surface which often results in the two layers separating. Examinations of semisilica brick removed from a furnace after various lengths of service showed that this protective coating reforms as slag erosion slowly wears the brick back.

LOW PLASTIC FLOW

Besides having an important advantage in structural spalling resistance, semisilica brick also have a distinct advantage over the clay brick group in that they do not deform or bend out of shape under stress at temperatures encountered in service. The standard load test data shown in Table I indicates they might be somewhat better than most high heat duty brick but the difference found in service is much greater.

A large tunnel kiln firing sanitary ware was built in 1923 with semisilica brick. In 1928 another kiln of similar design was constructed with high heat duty clay brick and used to fire the same kind of ware. In ten years the roof of the clay brick lined kiln had subsided

so much it was necessary to rebuild the kiln. It was estimated the roof dropped about ten inches during this time. After twenty-seven years, the first kiln is still in operation with no noticeable subsidence. This performance is typical of all tunnel kilns and has led to their use by practically all tunnel kiln builders in eastern United States where the temperature in the kiln is not over 2550 F.

TEST RECORDS ARE IMPRESSIVE

The construction details and temperature conditions of the arch in the above mentioned kiln indicate the approximate position of the arch after ten years' service showing a ten inch drop. When the records of these kilns are studied the following facts are revealed: (1) The back few inches of the inner course of brick must deform to permit the brick to subside. (2) The mean temperature of the coolest quarter of the wedge brick used in the arch is about 2150 F or less. (3) The time required for the arch to deform is so long that it is better described as "creep" or "plastic flow" rather than softening in the usual sense. (4) When semisilica brick are compared to clay brick or super duty brick in standard load tests run at 2460 F or higher, the results do not always indicate the most satisfactory brick for resisting deformation at high temperatures.

Attempts have been made by the speaker and others to evaluate accurately by the use of plastic flow tests or long time load tests the rates that refractories might deform in service. Some of the first tests made by the speaker seemed to check fairly well with the performance found in service, but unfortunately this did not hold true in all cases. Some of these tests were run at the same temperature that the brick reach in service which, of course, is somewhat lower than the temperature normally used for load tests — but in every case the pressure on the brick specimens was 25 psi or higher. The higher pressure was necessary to develop enough deformation in the time of the test to permit its measurement with reasonable accuracy. Since this high pressure is the only difference we are aware of between the tests and the performance of the various bricks in service, it probably is the reason why there is not perfect agreement. At any rate, as far as semisilica brick are concerned, it is still necessary to describe their properties by giving typical case histories of their behavior in service.

Another application where extremely long life is obtained with semisilica brick is in blast furnace stoves. We have one case where a blast furnace stove lined with semisilica brick in 1904 was still in use when the last check was made a little over a year ago. In this application, the semisilica brick do not deform and, consequently, can be used considerably longer than the higher alumina type brick. Figure 5 shows the area in a blast furnace stove where semisilica brick are considered to be used most effectively. They could be used all the way down as checkers. In areas where they must be shipped over long distances it is cheaper, however, to use high heat duty brick in this lower area where they usually hold up because the temperature is so low. Several feet on top of the checkers are often installed with super duty brick to take care of the possibility of an exceptionally high temperature in this zone. Since the super duty brick do not extend down too far (see Figure 5), they are not expected to deform to an objectionable extent. It is the opinion of the speaker that semisilica brick could be used all the way to the top of the checkers because they are capable of withstanding for a short duration temperatures as high as 2750 F; for long duration, temperatures to 2650 F.

Figure 5 — Cross-section of a blast furnace stove shows the area in which it is most economical to use semisilica brick. In localities where semisilica brick can be had without high freight rates it is advisable to use them further down in the checkers than shown.

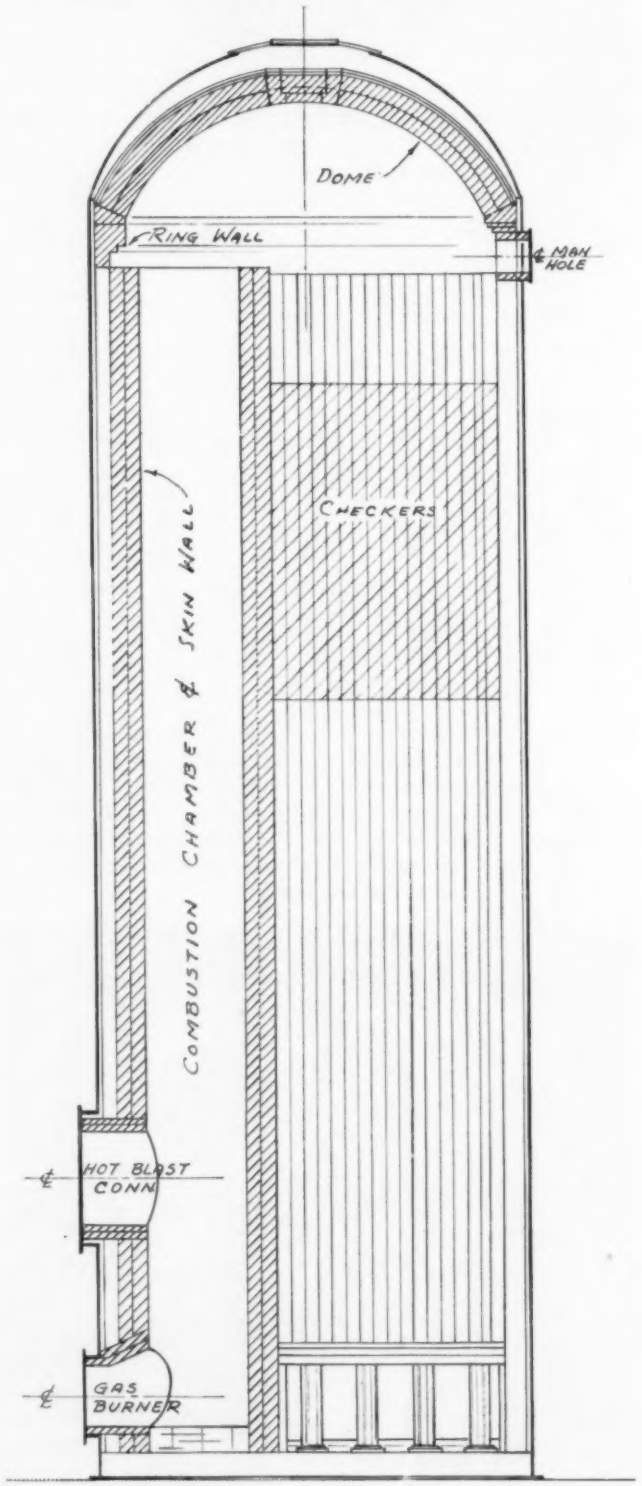


TABLE II

Semisilica Brick Compared to Clay and Silica Brick

	Plastic flow resistance	Thermal spalling	Structural spalling	Reversible expansion	Permanent expansion
High heat duty clay brick	Lowest	Best	Low	Lowest	Lowest
Semisilica brick	OK up to hot face temperature of 2800 F	Lower than clay. OK for large furnaces	Best	More than clay — less than silica	Midway between silica and clay
Silica brick	OK to over 3000 F	Lowest	Makes some trouble	Highest	Highest

Because the P.C.E. or fusion point of semisilica brick is low compared with the higher alumina bricks, it seems to make most engineers very conservative in their use. This is probably one reason why we have had so few failures or complaints on the refractoriness of this type brick. In many cases they could be used safely at temperatures as much as 100 F higher than some engineers think. No doubt the quality of semisilica brick to resist slag absorption contributes much to its ability to stand many years with little deformation.

EXPLANATION OF REFRACTORY NATURE OF SEMISILICA BRICK

In spite of the low fusion point of semisilica brick, their stability at high temperatures can be explained as follows: They are composed of two very refractory ingredients — silica with a P.C.E. of cone 33 and known to be capable of standing the severe conditions of the

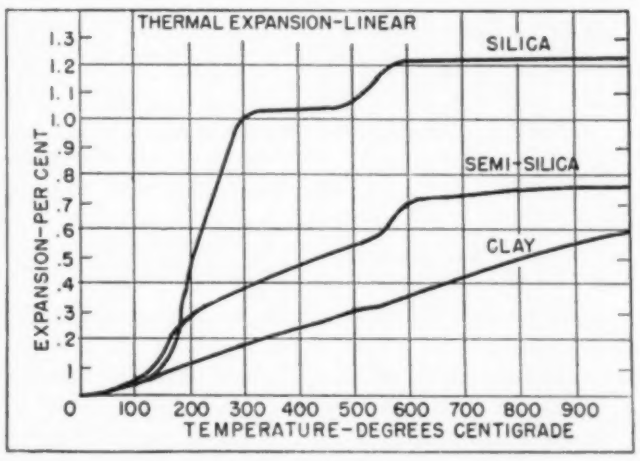


Figure 6 — Reversible thermal expansion curves for silica, semisilica, and clay brick test specimens.

open-hearth furnace — and a kaolin type clay having a P.C.E. of cone 32-33, if this clay portion is tested after being separated from the silica portion. Of course, in P.C.E. tests these two refractory components begin to react at the eutectic point (2820 F) to form glass.

Under standard P.C.E. test procedure, enough glass forms to bend the test cone by the time 2920-2950 F is reached. However when these brick are used as recommended, the temperature is below the eutectic point by at least 100 degrees or more, and these two refractory components do not react to form the low melting glass seen at the end of a P.C.E. test. Under conditions of service, the silica retains its refractory properties of high strength at high temperatures and tends to expand very slowly while the clay portion which gives the brick its resistance to thermal spalling tends to take up much of this expansion. The structure of semisilica brick is peculiar to this class of refractory. It is effective in retarding the reaction between the clay and silica portions up to temperatures quite close to the eutectic point.

EXPANSION MUST BE CONSIDERED

The maximum permanent expansion of semisilica brick is about three quarters as much as silica brick. This might be a little higher than expected, but it is accounted for by the fact that the silica portion contains a higher percentage of quartz. In practically every case, expansion is less than this because the clay portion of the brick is subject to plastic flow and some shrinkage in the temperature range where silica expands. This tends to offset most of the permanent expansion and in some cases, all of it.

Results of the plastic flow test previously mentioned indicate that at a pressure of 25 psi, the brick does not exhibit any expansion. In several cases it has been noted in practice that the permanent expansion is nil where the brick are under stress or retained by strong buckstays. In other cases where extra large expansion joints are used, the brick will most likely expand enough to close joints provided to allow for two per cent expansion. It is good engineering practice, however, to provide for one to one and a half per cent expansion. The reversible expansion compared with clay brick and silica brick is shown in Table II and Figure 6.

EFFECT OF SLAGS

Up to now, semisilica brick have not been offered in highly slag resistant grades. Porosity of semisilica brick runs from an approximate minimum of 25 to a maximum of 28 per cent. This high porosity is an advantage in giving the brick the ability to absorb the expansion from the silica they contain. This amount of porosity also increases the bricks resistance to thermal shocks. However, the protective coating that forms over the surface of semisilica brick enables them to stand up well in many applications where slagging conditions are not extremely severe. For instance, slags encountered in applications where the brick are recommended, usually wear them away so slowly that long life is obtained.

SEMISILICA BRICK USES

The over-all limits of semisilica brick require that their hot face temperature should not exceed 2750 F for long periods. Their inability to stand extreme thermal shocks limits their use in small furnaces that are heated and cooled daily. Larger furnaces that run for several days at a time, due to their great mass, will not cool or heat suddenly enough to develop thermal spalling troubles with this brick. Semisilica brick are normally used to overcome difficulties arising from structural spalling or deformation of furnace walls and roofs. Typical applications where semisilica brick have and are giving excellent service are for kilns, soaking pit covers, forging furnaces, heating furnaces of all types, hot metal mixers, checkers, checker linings, fantails of open hearths and blast furnace stoves.

Semisilica brick have overcome the trouble encountered in some high walls from bending inward. This has been the case in big reheating furnaces and some of the larger stoker-fired boilers. In the latter it was found economical to use silicon carbide refractories along the clinker line and semisilica brick for the rest.

There are two grades of semisilica brick offered on today's market. The one more commonly used contains 76 to 78 per cent SiO_2. However in certain boiler furnaces, it was found that a brick was needed having a higher resistance to thermal shock and a little higher modulus of rupture. This has led to the use of another grade containing about four per cent less silica. This grade compared to the regular grade has the same high resistance to structural spalling, better resistance to thermal spalling and a lower resistance to plastic flow. It is usually used in boiler furnaces.

DISCUSSION

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FRANK W. HAWKINS, Superintendent Slab and Bloom Division, Ford Motor Co., Dearborn, Mich.

R. J. STANLEY, District Manager, M. H. Detrick Co., Detroit, Mich.

Robert Sergeson: Can you give me a distinction between the super duty and the high alumina brick?

G. Bickley Remmey: Referring to the difference between semisilica and super duty and other high alumina bricks, I can say this, that the super duty and high alumina bricks undergo this structural spalling as do high heat duty, but with different degree. Of course, we know that super duty bricks resist that condition a lot better than do high heat duty brick, but they undergo structural spalling the same way. We do have records showing the semisilica brick not spalling where super duties have spalled and also high alumina brick. In fact, we have one that is almost embarrassing to repeat, but we do manufacture this other brick, so I do not see how anyone can take offense at it. We manufacture a 99½ per cent alumina brick.

During the past war, the Philadelphia Electric Co. were very much worried about being able to keep the boilers on the line, and they said, "Do you have something that we are sure is going to last longer," and between the engineer and myself, we thought if they wanted to pay the money they should try some of these 99½ per cent alumina brick. They had already tried super duty and high alumina brick. I said, "Go the whole way; put pure alumina brick in there at $1.84 apiece," and the same thing happened, the high alumina brick spalled and the semisilica brick was still in good shape. Of course, that does not mean they are better brick than high alumina. We could melt semisilica down five, six hundred degrees lower than where the high alumina brick will stand. It just shows, again, it is awful hard to avoid that structural spalling taking place in any refractory, but because the composition of the semisilica brick is so close to the eutectic, it forms a protective coating and checks the development of the structural spalling condition.

William Scharfenaker: I have used the material. I wondered if you can recommend the best kind of mortar to use with them, what clay?

G. Bickley Remmey: We usually supply Jersey clay. That has to be diluted with about 50 per cent fine Jersey grog. I mean semisilica grog, which, of course, is old semisilica brick ground up. That has worked out very good. This mixture is also sold ready mixed. There is no doubt other mortars would do a good job.

William Scharfenaker: The primary reason I asked the question is, that I have used both fire clay mortars and silica clay mortars along with semisilica brick, and I cannot see much difference.

G. Bickley Remmey: If the silica mortar is not too pure, it will probably work out fine. If it is as pure as some silica mortar, the mortar itself will expand more than the brick and make a separation in places. We have not run into too much trouble with mortars, excepting once in a while when somebody gets a furnace operating around 2400 F, and they lay the brick up with a high temperature cement, the soda is sort of absorbed by the brick at the corners and very often will cut out. So we do not recommend that unless it is in the back end of a boiler or some place where the temperature is down around 2200 F, or lower. We have not found much in the way of trouble using different mortars.

William Scharfenaker: You showed a kiln that you burn at 2750 F; is that kiln insulated?

G. Bickley Remmey: Yes, those kilns are now built with a 13½ in. semisilica roof. In back of that is 2½ in. of 2300 F insulating brick, 2½ in. of No. 20 insulating brick and 1½ in. of 1500 F; block insulation.

William Scharfenaker: Could I gather from your earlier statement that the maximum sustained operating temperature of 2750 F heated from one side and 2650 F heated from more than one side, regardless of whether it is insulated or not, means that the maximum sustained operating temperature is still 2750 F?

G. Bickley Remmey: The temperature drop through any wall that is insulated with any sense of economy would be great enough so that it would stand up well at 2750 F. In fact, the side walls of that kiln have nine inches of insulation in back of it.

William Scharfenaker: You would not anticipate any reduction in the maximum operating temperature so long as you heat from one side whether it is insulated or not?

G. Bickley Remmey: That is right. The temperature drop through the brick only has to be a few hundred degrees, and you are down in the range where you have great stability in semisilica brick. If we put one of our own semisilica brick in that kiln at 2750 F, we may get as much as ⅛ in. shrinkage in 9 in., yet we do not see any shrinkage cracks in the wall.

William Scharfenaker: What prompted me to ask the question was where you said fan tails is the place where the brick can be used. We have semisilica brick in some of our fan tails and in an effort to cut down air infiltration and leakage we have been putting refractory concrete over it. I wondered if we have the right thickness, whether that makes too much difference?

G. Bickley Remmey: I do not think you would ever pile enough insulation on to hurt it if hot face temperature is under 2750 F. The brick is a funny thing. For instance, in the panel spall test, semisilica brick are heated on one side at 2900 F for 24 hours, which usually develops shrinkage cracks and glaze all over the bricks, but they stay in there and they hold the heat. The shrinkage cracks only go back a half inch or so, and the temperature falls off to a point where the brick did not shrink any.

The average use of semisilica brick I feel is very conservative. Most tunnel brick builders say they would not use them much above 2500 F; at temperatures higher than 2550 F they would go to silica brick. I would not hesitate to use them at least 100 degrees higher than that, even though it is a continuously operated kiln. Of course, maybe it is a good way to let them be, because we very seldom get a complaint from melting. Everybody is more scared of the brick melting than we are, but they do not get used in some places where they might be. As far as I know, I do not remember a complaint on melting for fifteen years. Before that time we used to get them, because lack of knowledge of the bricks and furnace conditions sometimes resulted in their misuse.

Member: Talking about melting, you probably answered my question there, but have you ever used a semisilica in electric furnace melting arcs?

G. Bickley Remmey: Not to any extent; usually your electric arc is too hot.

Member: I have seen straight clay used.

C. Bickley Remmey: I would ask how long the clay lasts.

Member: About 50 per cent of that is silica.

G. Bickley Remmey: Would that be one week or two weeks? If the clay brick had a very short life, I would be reluctant to put the semisilica brick in, but say it ran a couple months and then started to spall, that would indicate that the temperature is down to a range where you can get away with semisilica brick. If, however, your temperature is so hot that you would have your roof slumping in with high heat duty brick in a period of a couple weeks or less, the chances are you would melt the semisilica. It would be too hot, and then they will go down faster than the other brick. Usually if the ultimate cause of failure is spalling, it is usually safe to put the semisilica brick in. In other words, if the high heat duty brick will last long enough to develop structural spalling, rather than melting, the temperature is usually low enough to safely use semisilica.

Paul Lindberg: What is the price differential between high alumina brick, and silica brick? Is the semisilica in between the two?

G. Bickley Remmey: Semisilica brick in the Philadelphia area are delivered close to the plant a little cheaper than high heat duty brick. I think they are $6 more a thousand at the plant than the high heat duty brick are, so that by the time you get them out here in the Detroit area, it is $6 plus the freight. I guess that would be maybe on the order of $20 more. If they are used in the places mentioned to overcome structural spalling or deformation troubles, that difference in price is very trifling compared to the life you get. The silica brick, I think, are about the same price as high heat duty clay brick, and, of course, the high aluminas are higher priced yet.

Ted Harley: Frequently in these new heating furnaces which are constantly being installed, a question often arises whether we should put in semisilica or a good high hard fired, high heat duty brick or super duty brick. I have seen the semisilica brick do a beautiful job if used properly.

A question has come up recently concerning the statement Mr. Scharfenaker made concerning the use of insulation on a suspended roof, particularly in the heating zone. It has been my observation on several installations that small frog eyes develop on the roof of these semisilica installations, particularly in sprung arches. Sometimes the hot mill operators begin to cry for production and push the furnace rather hard, consequently getting the temperature up there quite high.

I am wondering what your thought is concerning, say, two and a half, three or four inches of insulation, and whether or not you have ever noticed these frog eyes, and if that is a sign of the approach of a drip? If it is a drip, you know what the hot mill superintendent is going to say.

G. Bickley Remmey: That is one of the reasons I

have been a little partial to the arch roofs, because the slag that forms, after the furnace gets used a long time will sort of run down the side. Those drips are likely to occur. This frog eye is, I suppose like the start of one?

Ted Harley: Tear drop.

G. Bickley Remmey: I do not know any solution to that once it starts, because there is usually quite a long life obtained before it begins to drip. If there is a spring to the roof, it does pretty much drain down on the one side or the other, and you can duck the drip in the middle of the furnace.

Member: On a flat suspended roof, would you recommend the use of as much as two and a half, three inches of insulation on the heating section of the roof?

G. Bickley Remmey: I think that would be safe on semisilica, yes. If it is suspended, you have the iron hangers to contend with. You cannot let them get too hot. If you save the iron hangers, you certainly are going to save the brick.

That dripping has come up once or twice, although we do not seem to get too much complaint from it. Probably we get a long enough life to satisfy them before it develops.

Insulation plays an important part in this dripping. If no insulation is used over the area the dripping is to be prevented, then the hot surface of the brick is cooled enough to retard the formation of these drips if not prevent them.

Fred McNaughton: What would you recommend for a cooling-off cycle in a stove like that?

G. Bickley Remmey: I do not know enough about the operation of a blast furnace to speak intelligently on that. I look at them usually with the point of view of trying to diagnose what the situation is.

Fred McNaughton: I wondered whether it should be two weeks or two days. If you cool the stove down too fast, would it have any effect upon this semisilica brick? You want to take the stove off and get it off as quickly as you can as you have some repair work to do. You want to get it back on the furnace as soon as possible.

G. Bickley Remmey: It seems to be impossible to cool a furnace that large, too quickly, for semisilica brick. A small furnace, might be cooled down with air in a couple of hours, but you cannot do that with a large kiln or stove. You can see the thermal shock that they will take in the soaking pit cover application. They will take a thermal shock that is encountered in pit covers, so you will not be able to cool a stove or any of these other big kilns fast enough to develop spalling if you use air — not water. There is a possibility around the door opening you might get a few checks, but in big furnaces, usually you are not bothered with spalling at all.

Ted Harley: How about expansion joints in large wall installations; what is your recommendation for expansion joints?

G. Bickley Remmey: We usually recommend you provide about one to one and a quarter per cent room for expansion. If the furnace is heated high enough it would cause the quartz in the brick to convert, which will develop enough expansion to close the joint. If the furnace has good heavy buckstays, no further expansion will develop. Reversible expansion in semisilica brick is about 1 per cent. Expansion resulting from conversion of the quartz is absorbed by the clay bond in the brick, if the brick is enclosed in strong buckstays. This is because the clay portion of the brick has plastic flow at temperatures high enough to convert the quartz.

Frank W. Hawkins: What relation does the fuel have on the spalling? For instance, some people use 140 Btu gas; some people use 1000 Btu.

G. Bickley Remmey: When I mentioned these slags penetrating the brick, I was thinking more of fuel oil and coal and coke firing applications where we do have some ash in the fuel, and part of that ash is composed of alkalis, iron, calcium and magnesium, which contact and chemically attack the brick. Burning with gas, you get very little, if any, flux on the brick, so you would not get drippings. If you are firing with natural gas, you probably would not get dripping from the roof. Of course, you would get some iron oxide or are you thinking of furnace stoves?

Frank W. Hawkins: I am thinking of soaking pits.

G. Bickley Remmey: With natural gas I do not think you would have to worry about the dripping. It would take an awful long time for the iron oxide to build itself to sufficient quantity to cause that heavy build-up of slag. If you are firing with bunker oil, you get the accumulation of slag much sooner and in larger amounts, because even though there is only a few hundredths per cent ash in the crude oils, so much oil is burnt that sufficient alkali concentration is developed in the furnace gases to attack the hot surface of the brick work, it reacts very readily and causes the glaze. But if you have natural gas, you would probably be rid of that problem. I do not think you have to worry about it.

R. J. Stanley: Do you have any furnace pressure in one of those kilns, the one you showed?

G. Bickley Remmey: We have a neutral zone between about three and five feet up from the floor. By that I mean at that point pressure is zero, below that point, you would have a draft or vacuum, above that, you would have pressure and, of course, the higher up you go, the higher the pressure would be. We have run the kilns with the neutral plain all the way down on the floor, which puts considerable pressure on the top, because the kilns are over 12 ft high. With the metal encasement on the kiln, that does not bother us. But with kilns built without metal sides, this pressure is sometimes enough to force heat through cracks in the walls and build up enough temperature on the insulating brick to melt them.

Robert Sergeson: Will the semisilica brick withstand the lithium atmosphere in these furnaces?

G. Bickley Remmey: What furnace do you have lithium in?

Robert Sergeson: I believe Ford Motor were trying at Canton, Ohio, a lithium atmosphere that keeps down scaling and decarburization, and I know lithium does attack some bricks.

G. Bickley Remmey: It would attack semisilica brick. I think you would get the same condition.

PROCESSING, PROPERTIES, AND APPLICATION OF COLD FINISHED CARBON STEEL BARS

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. . . . a wide range of properties for many different sections may be developed in the cold finishing operation . . . .

▲ THE term "cold finished bar steels" is rather broad and indefinite and does not designate the specific type of cold processing involved. For the purpose of this discussion, it may be well to develop, in a general way, the various methods of cold processing employed in order to obtain the proper combination of properties for our various applications.

There are five basic processes for producing cold finished bars, namely: cold drawing, cold drawing and grinding, cold rolling, turning and polishing and turning, grinding and polishing.

In Table I are shown the several types of cold finished material with a brief description of their physical characteristics, types of finish and degree of size accuracy.

Of the five production methods mentioned, cold drawing and turning and polishing are most frequently employed. Cold drawing is the principal method used in the industry due to the fact that it is applicable to a wide range of shapes including rounds, hexagons, squares, flats and special sections; plus the improved physical properties and machining quality which result from this practice as compared to hot rolled material.

Our discussion will be limited to the processing of, and the properties and applications involved in the production of cold drawn and turned bar stock in carbon steels.

Historically, the practice of cold working metals dates back to Old Testament times when metals were hammered into plates and wire. Wire drawing using die blocks was practiced in England as early as the eighth century and commercially as early as the 1400's. The first cold drawing in this country was done in New England at the time of the Revolutionary War. The product was wire and the material used wrought iron, copper, brass, etc. During the period of the Civil War, steelmaking processes made their appearance and a process for cold rolling metal was developed and

TABLE I

Types of Cold Finished Steel

Processing	Physical characteristics	Description
Cold rolled	Cold drawn properties	Commercial cold drawn finish and size accuracy
Cold drawn	Cold drawn properties	Commercial cold drawn finish and size accuracy
Cold drawn and ground	Cold drawn properties	Ground finish and very close size accuracy
Turned and polished	Hot rolled properties	Turned and polished finish; cold drawn size accuracy
Turned and ground	Hot rolled properties	Ground finish, very close size accuracy

patented by Bernard Lauth. This process utilized a hot rolled bar, in larger sizes than heretofore possible, scale free, with repeated passes through rolls with light drafts until the desired finish size was obtained. This product was generally similar to present cold drawn bars in appearance, finish, size accuracy and physical properties. As a production method, however, cold rolling is a comparatively slow and inefficient process. At the present time, cold rolling is confined to certain items which do not lend themselves to cold drawing, such as wide flats. Cold finished production of bar sizes has in recent years featured either cold drawing or turning, depending on the section, size and properties required.

COLD DRAWN

Cold drawn material is produced from hot rolled bars or coils which are specially processed for this purpose.

To prepare hot rolled unannealed carbon steel for cold drawing, the scale is removed by pickling in a 5 to 7 per cent sulphuric acid bath, temperature about 160 F, to which an inhibitor has been added. An inhibitor is an organic substance which restrains the action of the acid on the bare steel after the scale is removed.

Sulphuric acid removes ordinary scale by penetrating the minute fissures in the scale. In the ensuing chemical reactions, hydrogen is evolved which dislodges the scale from the bar. When the steel has been suitably pickled or "cleaned," it is thoroughly washed with water, then dipped in a hot 4 per cent lime solution and allowed to dry. This lime coating serves a three-fold purpose; it neutralizes the last traces of acid, serves as a temporary rust preventative, and acts as a lubricant in conjunction with a soap or oil during cold drawing. After the bars or coils have been pickled, washed and limed, they are ready to be cold drawn through dies, using dry soap, a water soluble compound or a mineral oil as a lubricant.

The actual drawing operation consists of pulling or drawing the pickled and limed hot rolled bar through a die by means of a draw bench. This mechanism, shown on Figure 1, ranges from 30 to 45 ft in length and consists of three main parts, the drive, pointing head and pulling or drawing head.

The drive involves a variable speed electric motor activating an endless chain running from one end of the bench to the other. The pointing head is a mechanism which grips the bars to be drawn and pushes them through the dies sufficiently to permit gripping by the draw head. After push pointing, the jaws of the draw head grip the pointed end of the bar and the draw head is hooked to the endless chain which furnishes the drawing power.

The hot stock may also be pointed by cold swaging or "over pickling" to effect a reduction of approximately $\frac{1}{16}$-in. diam for 6 to 8 in. of the bar end.

Lubrication of the bars, in addition to the lime coating already present, features either a grease box in front of the die or a stream of soluble oil directed on the bar just prior to entering the die. The combination of lubricant and lime coating promotes improved bar finish and die life.

The speed of drawing varies considerably depending upon drawing equipment, bar size and section, quality of finish, chemistry, amount of draft, etc. A range for commercial drawing speeds would be from 40 to 100 linear fpm. Some sections may require speeds as slow as 10 fpm, and others as high as 300 fpm.

Figure 1 — Draw bench mechanism consists of three parts, drive, pointing and drawing heads.

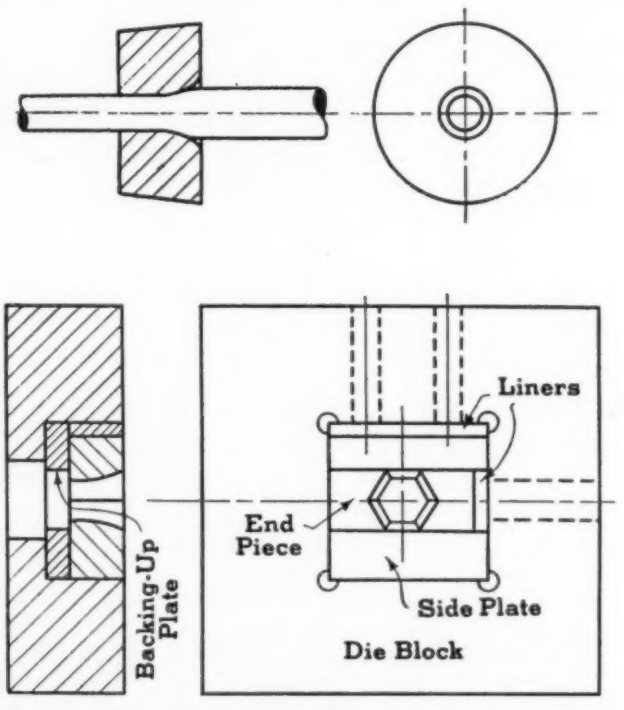


Figure 2 — These drawing dies illustrate the two types commonly used. Top shows solid type drawing die, and bottom shows set-up type cold drawing die.

Drafts or reduction in diameter from hot rolled to cold finish size may vary from $\frac{1}{64}$ to $\frac{1}{8}$ in. Again the amount of draft employed depends on such variables as bar size, section, grade of steel, physical properties and surface finish required.

Dies for cold drawing are either solid or set-up types, manufactured from alloy steel or tungsten carbide. Rounds up to approximately $3\frac{3}{4}$ in., and hexagons up to $1\frac{1}{2}$ in., are drawn through solid dies made of tungsten carbide, or high carbon and high chromium steel, oil quenched. The set-up type is used for large hexagons, squares, flats and special sections. A sketch of the two types of dies is shown in Figure 2.

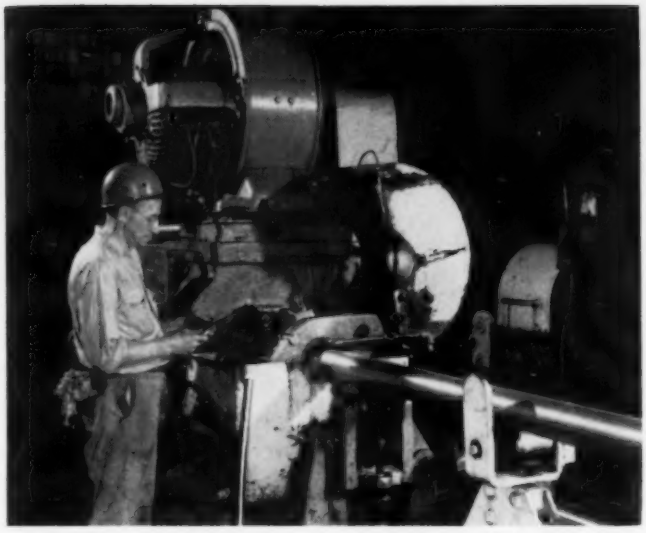


Figure 3 — Only rounds can be produced by turning.

TURNED AND POLISHED

Still another method of cold finishing steel bars is turning and polishing. This method is applicable only to rounds. The hot rolled bars, in sizes ranging from 1¼ to 8-in. rounds are reduced in diameter, 1/16 to 1/8 in. in a centerless type turning machine where the metal is actually turned off the surface by cutting tools. One of these machines is shown in Figure 3.

The rough "turned" bars are polished in a reversible cross roll type straightener, which also serves to straighten the bars.

This process produces a highly polished bar, free from surface defects and decarburization, with the finish, size and straightness characteristics of cold drawn material but with the physical properties of the original hot rolled bar.

TURNED, GROUND AND POLISHED
COLD DRAWN AND GROUND

In either of these types, the finish and size accuracy are obtained by grinding and final polishing. In both cases, this means a high standard of accuracy in size and smoothness of surface. The physical properties of the turned and polished and ground and polished bars are those of hot rolled stock, the physical properties of the cold drawn, ground and polished are those of cold drawn steel.

Straightening after cold finishing is necessary to meet the exacting straightness requirements demanded by the trade. For cold drawn rounds and turned stock, the most popular type of straightener is a cross roll type machine consisting of one concave and one straight roll. The bar, fed horizontally between the cross rolls under sufficient pressure, revolves as it passes through the rolls. In addition to being straightened to close accuracy, the bar is also polished to some extent due to the burnishing or wiping action of the rolls.

Hexagons, squares, flats and special shapes are straightened either by means of the staggered roll type straightener or by gagging.

Where extremely close straightness requirements are indicated, straightening by hand or by power gagging may be necessary. This type of straightening is most popular for large turned and polished or turned and ground rounds.

PROPERTIES

It is generally agreed that cold finished steel is in demand by the trade due to any one or a combination of the following properties: (1) smooth surface, freedom from scale; (2) close size and section accuracy; (3) improved straightness over hot rolled; (4) improved physical properties; and (5) improved machinability.

As previously discussed, in pickling and drawing operations, the hot rolled scale is eliminated and the action of the die and straightener produces a smooth, bright surface reasonably free from objectionable surface pitting and defects. These characteristics make the product desirable for shafting and machined parts, particularly if the finished parts retain a portion of the original bar surface.

One of the outstanding features of cold finished steel is the close dimensional tolerances that can be maintained. Table II compares the permissible variation in size and out of round of hot rolled and cold drawn material.

TABLE II

Size Accuracy Hot Rolled vs Cold Finish Rounds

Size	Variation from size, in.	Out of round, in.
½-in. Round hot rolled	±0.007	0.010
½-in. Round cold drawn	—0.002	0.001
1-in. Round hot rolled	±0.009	0.013
1-in. Round cold drawn	—0.002	0.001
2-in. Round hot rolled	±0.015	0.023
2-in. Round cold drawn	—0.003	0.0015

There are no published standards on straightness for cold finished bars. However, the degree of straightness required by cold finished customers is usually close. Requirements may vary considerably depending on the job and are frequently a matter for negotiation between producer and consumer.

Cold drawing effects a pronounced change in the physical properties of bar steels. Data to be shown are general in nature and do not necessarily represent the values obtainable under all conditions. They suffice to show, however, the marked increase in tensile strength and particularly yield strength that occurs in this process. Also since hardness and fatigue are generally proportional to tensile, these features are likewise affected.

Figure 4 shows the typical stress-strain curves for hot rolled and cold drawn bars. The tensile strength, it will be noted, is increased less than the yield. This characteristic of cold drawn steel is of considerable significance since the permanent set or distortion, which is a function of yield strength rather than tensile, is an important feature from an application standpoint. As might be expected, the marked increase in yield, tensile and hardness resulting from cold drawing are accom-

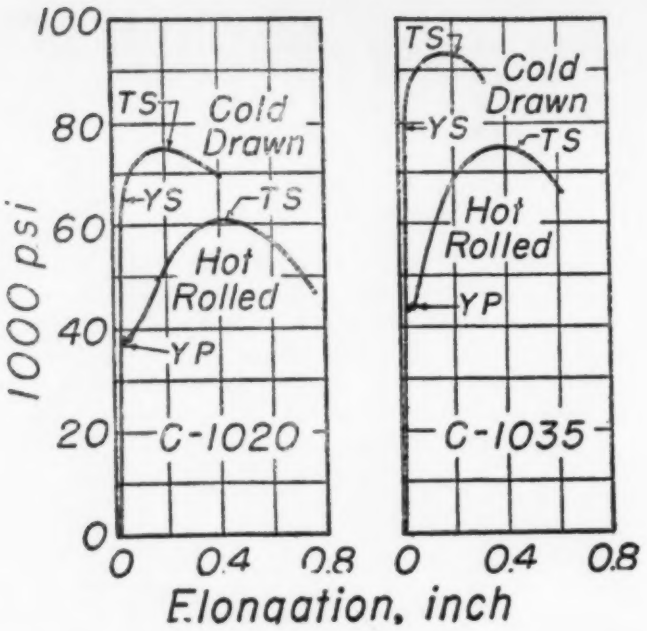


Figure 4 — Cold drawn products have higher yield and tensile strengths than hot rolled. Ductility is, however, less.

panied by a decrease in ductility as measured by elongation and reduction of area in tensile testing.

Table III shows mechanical property expectancies of several popular grades of steel in the hot rolled and cold finished states which will illustrate the characteristics previously described.

Variation in mechanical properties of cold drawn material can be achieved by chemistry as shown in the previous illustration, by varying amounts of cold work in drawing, and by thermal treatments prior to or following the cold drawing operation. Higher carbon and manganese content serve to increase hardness, tensile and yield strength and lower ductility.

A cold drawn bar with properties intermediate between the extremes in tensile and yield strength and ductility can be produced by annealing or normalizing before cold drawing.

Thermal treatment after cold drawing in the range of 500 to 700 F (strain drawing) can in many grades be used to produce slightly improved yield and tensiles without appreciable loss in ductility over the as cold drawn bar.

. Treatment at higher temperatures up to approximately 1100 F (strain relief) serves to relieve cold working strains to some degree and increase the ductility of the material with a corresponding loss in yield strength and tensile, particularly yield strength.

These treatments serve to modify or enhance certain properties of the cold drawn bar but have little or no effect on surface finish or size accuracy of the cold drawn bar.

Another important characteristic or property of cold drawn steel is machinability superior to that of hot rolled products. This superiority may be attributed to the beneficial effects on machinability produced by the cold work effect of cold drawing. This property is essential to today's high speed screw machine operations.

APPLICATIONS

The uses of cold drawn steels have become so widespread that their applications are too numerous to attempt to cover completely. The more common uses include spark plug shells, bolts, nuts and screws, gears, piston pins, auto parts, bushings, pins, shafting and various ordnance jobs. Although the above is by no means a complete list, it becomes evident that the cold finished bar business is a decided specialty.

Applications using cold finished bars require properties ranging from the extremely soft and ductile material to the maximum hardness, yield strength and tensile strength obtainable in the cold drawn state. In addition machinability may be a factor in the requirements or it may be the prime requisite for the particular job.

In Figure 5 we have tried to illustrate the range of property requirements of cold finished applications. Part "A" is produced from a ½-in. round, cold drawn, thermally treated low carbon steel. Fabrication of this part involves severe cold forming operations requiring maximum ductility or formability, good clean surface and sound cross-section. For good performance in the cold forming dies, close size accuracy and straightness are important.

Part "B" is produced from a 1 5/16-in. cold drawn round, in a free machining grade. This part, as shown, requires extensive removal of metal from the solid bar, necessitating the highest possible order of machining quality. Close size accuracy and straightness are required for proper automatic screw machine operations.

Requirements of part "C" are primarily high hardness and yield strength obtained in a medium carbon free cutting grade. A high order of machining quality is indicated inasmuch as this part is made on automatic screw machines.

TABLE III

Representative Mechanical Properties — Hot Rolled vs Cold Drawn

Grade	Size	Yield strength, psi	Tensile strength, psi	Elongation, per cent	Reduction in area, per cent	Brinell hardness
C1020	1 1/16-in. Round hot rolled	35,240	59,100	30	55	118
C1020	1-in. Round cold drawn	65,120	75,750	20	51.7	156
C1035	1 1/16-in. Round hot rolled	45,240	75,100	25	45	149
C1035	1-in. Round cold drawn	75,240	85,240	15.2	41.2	197
C1045	1-in. Round hot rolled	50,100	89,150	20	40	179
C1045	1-in. Round cold drawn	90,200	100,000	10	35	212

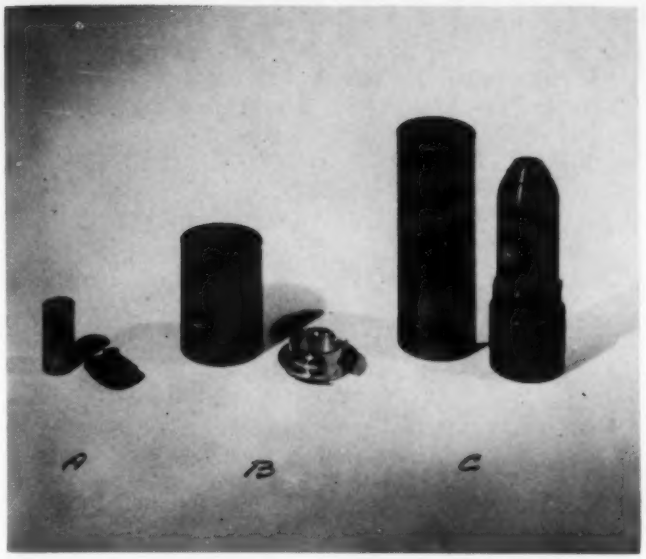


Figure 5 — These three products illustrate the wide range of products produced from cold finished stock.

From the thousands of applications and parts manufactured from cold finished bars, these three examples serve to illustrate the versatility, the wide ranges of applications and properties involved in the cold finished trade.

Consumers of cold finished bars range from those who use a few pounds per year to those who purchase as much as 25,000 tons per year. In distributing the product to the trade, warehouses generally service those customers whose requirements tonnagewise are small; larger consumers can be more efficiently supplied by shipments from the mills.

As an illustration of the types of applications in the cold finished trade, the following distribution data for an average peace time year are of interest:

	Per cent
Warehouse	27.9
Automotive	29.9
Home appliance	3.1
Agricultural	7.5
Machinery	16.1
Other	15.5

It is appreciated that the above percentages will vary somewhat from year to year. Ordnance items, for example, today represent an appreciable percentage of cold finished production.

SUMMARY

In this discussion we have attempted to point out the variety of properties and products that have been developed in the cold finished business.

It has been the aim of the steel producer to continually strive to develop processing procedures to produce a product with specific properties designed to fill the exacting requirements of the trade.

Progress has been made in this direction in the past; currently development work is being carried on in such fields as improvement of cold drawn physical properties, developments in the processing of special sections, further improvements in machinability, and thermal treatments of cold finished material, including surface carbon restoration of cold finished bar stock.

It is to be expected that these and future efforts will result in a further expansion of the field of cold finished applications.

DISCUSSION

PRESENTED BY

FRED HORN, Superintendent, Bar Mill Steel Div., Ford Motor Co., Detroit, Mich.

W. W. TRINKS, Associated Engineers, Farmers Bank Building, Pittsburgh, Pa.

Fred Horn: In your practice is any conditioning by grinding or chipping done on pickled bars prior to drawing? Is that permissible in some cold drawing processes?

J. F. Byers: In our practice, bars are not ground or chipped after pickling and prior to cold drawing. Conditioning for removal of surface defects is generally performed on billets prior to hot rolling. Some degree of chipping or grinding is sometimes permitted on hot rolled bars for extrusions or hot forging operations.

Fred Horn: I assume that the cold drawing operation is sometimes used as a means of control to yield tensile strength. By what means does the customer have the opportunity to specifiy the type of steel and also the physical properties?

J. F. Byers: Cold finished bars are furnished to standard AISI grades on chemistry. It is possible for a customer to specify steel with physical properties which are consistent with the grade and processing employed.

W. W. Trinks: What happens if much higher drawing speeds are used than are commercially used? What happens to the die and to the steel?

J. F. Byers: Die life and the effect on the steel due to extremely high drawing speeds are probably largely a matter for conjecture. The results obtained would be influenced by a number of other factors including grade of steel, lubricants, size, and the amount of draft taken.

W. W. Trinks: I had in mind, for instance, continuous drawing. There higher speed would pay. With the short lengths that are drawn now, it certainly would not pay, but with continuous drawing it would pay. Therefore, I would be interested in speeds that are three or four times as high as they are now.

J. F. Byers: Cold drawing and straightening from coils would approach this condition. However, drawing speeds obtainable would be determined by the amount of draft, grade of steel and the limitations of the equipment.

Mechanized Hot Scarfing

By J. H. ZIMMERMAN
Manager
Development and Process Service
Linde Air Products Co.
New York, N. Y.

. . . . the day is approaching when the completely automatic scarfing machine will be in operation . . . .

▲ SINCE the beginning of mechanized hot-scarfing on a mill production basis, there has been a steady increase in the number of scarfing machines in operation as well as in the tonnage and variety of steel products scarfed. There are currently over 40 machines in service in the United States, Canada, and Great Britain. Additional desurfacing machines are now in the process of installation and construction.

The steady increase in steel tonnages hot-machine-scarfed is shown in Figure 1. In 1951, 8.4 per cent of the total United States ingot production was conditioned by hot-scarfing. In terms of tonnage, this represents approximately 8,700,000 tons. It is estimated that machine-scarfed tonnage in 1952 will reach 10 per cent

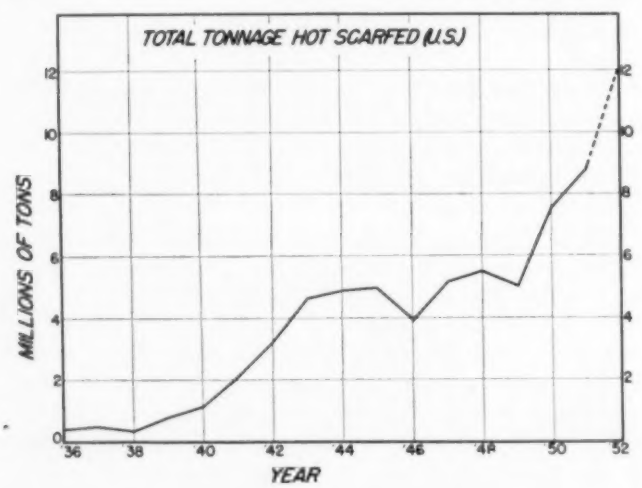


Figure 1 — This graph shows the steady increase in steel tonnages which are hot-machine-scarfed.

of the total United States ingot production. While hand-scarfing operations continue as the major conditioning process, this trend toward mechanization is of importance.

The demand for machine scarfing arises primarily because the machines reduce or even completely eliminate manual secondary conditioning. Increasing costs for manual conditioning, inspecting, handling, and reheating serve to emphasize the advantages of direct rolling practices, as employed by some mills for many years. In such practice the semifinished product is hot-scarfed, sheared, hot charged for reheating, if necessary, and finish rolled with no diversion from the production line. With hot-scarfing machines in the steel production line, manual secondary conditioning is reduced, and greater production of finished steel is possible. Valuable areas of mill space and crane facilities may be made available for other uses by reductions in hand-scarfing requirements. Also, conditioning ceases to be a bottleneck, and higher yields of good steel can be obtained. As a result, inventories of steel in the process of manufacture can be considerably reduced, and production better adjusted to fluctuating demand.

Benefits of mechanized hot scarfing are:

1. *Reduction of a production bottleneck.* Mechanized hot-scarfing drastically reduces and, in some cases, completely eliminates the need for manual secondary conditioning, and provides for a much smoother flow of steel from the primary mills to the finishing mills.
2. *Decrease in manpower requirements.* In actual practice, the average machine installation has reduced conditioning department personnel from 50 to 75 per cent or higher.
3. *Decrease in conditioning costs.* Actual reported direct savings over manual conditioning have varied from less than $1.00 to as high as $7.00 per ton. The average direct saving is conservatively placed at $1.50 per ton.
4. *Improvement in quality and yield.* A decrease in rejects has been the usual experience wherever machine-scarfing has been installed.

PRODUCTS SCARFED

Any steel or alloy that can be cut by the oxy-acetylene flame can be hot-scarfed. Because steel can be hot-scarfed at rolling temperatures, even those grades and types which cannot, for metallurgical reasons, be hand-scarfed without preheating, can be as readily hot-scarfed as plain low carbon grades.

In practice, all carbon, and many alloy grades, either killed, semikilled or rimmed, are being conditioned by hot-scarfing. Generally, hot-scarfing is done on steels which are required to have a defect-free surface for the sake of the surface itself. This group includes light-gage sheet, tin plate, and other similar materials. Other steels that are hot-scarfed are those which receive a great deal of work either in the forming stage or in their ultimate use, and in which surface defects would likely cause rupture. Some examples of this group are forging stock, cold-heading stock, and deep-drawing or seamless tubing stock. Hot-machine-scarfing is also beneficial in the creation of high-quality surfaces for finished products to be subjected to repeated stress where minute surface defects or decarburized areas may serve as the starting points for progressive failure cracks.

Table I lists some of the types of steel hot-scarfed in the United States and Canada.

TABLE I

Representative Types of Steels Hot-Scarfed

Forging	Merchant mill products
Seamless tubing	Tool steel
Deep drawing	Drill steel
Cold drawing	Spring steel
Die rolled products	Gun barrels
Wire Products (automotive, rope, piano)	Transformer steel
Strip products (coiled, razor blade, tool steel)	Rails
Tin plate	Shell stock
Plate	Bullet core
Skelp	Cold heading stock

TYPES OF SCARFING MACHINES

A wide variety of scarfing machine designs has been made available to meet practically every mill requirement. Three sizes of our billet and bloom scarfers cover the ranges of 2 × 2 to 6 × 6 in., 4 × 4 to 10 × 10 in., and 5 × 5 to 14 × 14 in. Other available scarfing machines hot-scarf; (1) slab edges only, up to 8½ in. thick, and (2) single slab surfaces, either top or bottom, up to 76 in. in width. (These latter machines require slab turnover, and a second pass through the machine.) More recently, the machine shown in Figure 2 has been developed and built to scarf simultaneously both top and bottom surfaces of slabs up to 72 in. wide. Another machine, even larger, has been designed to scarf the four sides of slabs simultaneously, up to 8½ in. thick and 75 in. wide, see Figure 3. Large machines of this type have also been proposed to hot-scarf four sides of either slabs or blooms by extending the vertical scarfing dimension to 14 in. In addition, various special machines can be made available for the selective scarfing of defective surface areas of beam blanks, rail blanks, and other similar materials.

There is quite a difference between early experimental scarfing machines and the present day models. Early machines consisted only of a few individual scarfing blowpipes mounted side-by-side. Today, machines incorporated electrically controlled mechanisms to make hot-scarfing a highly efficient and economical operation.

The transition from the early models to the modern machines shown in Figures 2 and 3 involved the solving

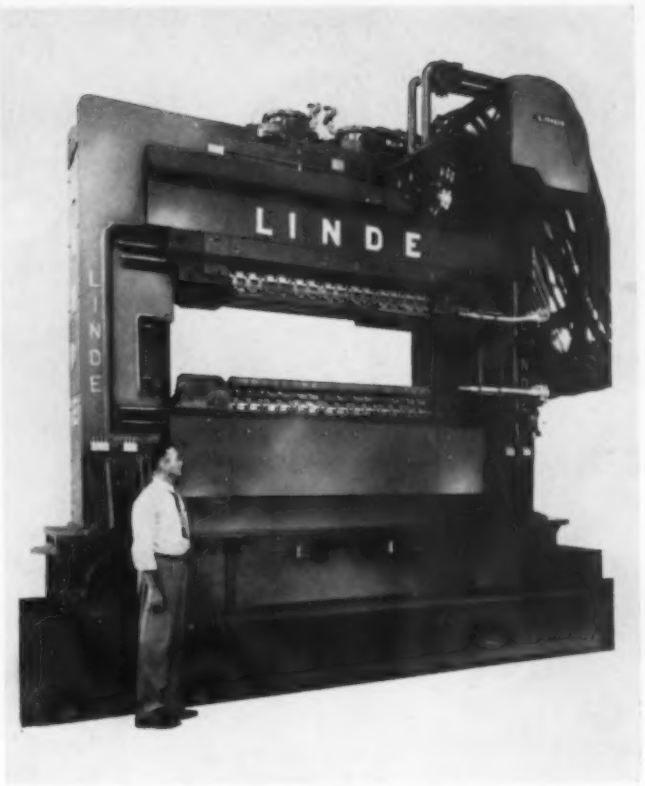


Figure 2 — This machine scarfs top and bottom surfaces of slabs up to 72 in. wide, simultaneously.

of many complex and unique engineering problems. These machines represent the combination of many unusual features of construction. Many high precision parts, essential for safe handling of large volumes of gases, and for providing smooth mechanical flexibility and adjustability, are used in the machines. These parts are combined with others to give the machines maximum ruggedness and stamina. The need for quick interchangeability of scarfing units has been recognized and incorporated into the machines with many other features to give a high degree of accessibility for easy maintenance.

BASIC MACHINE FEATURES

While these machines vary widely in physical size and in size of product scarfed, they all have the same general basic machine features. For example, since billets, blooms, or slabs are never truly straight, the machines have been made instantly self-adjusting by means of a floating mechanism to follow both horizontal and vertical camber in the steel being scarfed. Thus the scarfing nozzles, which are held firmly against the steel surface with only a light pressure, maintain a fixed relationship with the steel even though it may have several inches of camber.

To accommodate sections of various sizes within the specified size range of a particular machine, means are provided for changing the relative position of scarfing units, as well as selecting the proper number of scarfing nozzles required. This can be done quite rapidly for a given size bar or slab. Size changing and nozzle selection may be accomplished either manually or by air-motor drive, depending on the size of the machine and the frequency of changes in size of the steel to be scarfed.

Motor-driven carriage mounting of the scarfing machine permits rapid movement of the machine into or out of the mill rolling line. A short section or roll table automatically fills the gap as the machine is retracted from the scarfing position in the table line. This feature allows the machine to be removed from the line while those heats of steel not usually scarfed are being rolled, and permits the performance of routine machine maintenance activities without interfering with the normal rolling schedule, and without subjecting the operator to undue hazard.

Scarfing machines incorporate electrically operated sequence timers to control the various machine functions. After the steel to be scarfed has been positioned within the machine for scarfing, the operator simply depresses the main scarfing switch to energize the sequence timer. In their proper time sequence, the scarfing nozzle units surround the steel, the gases are

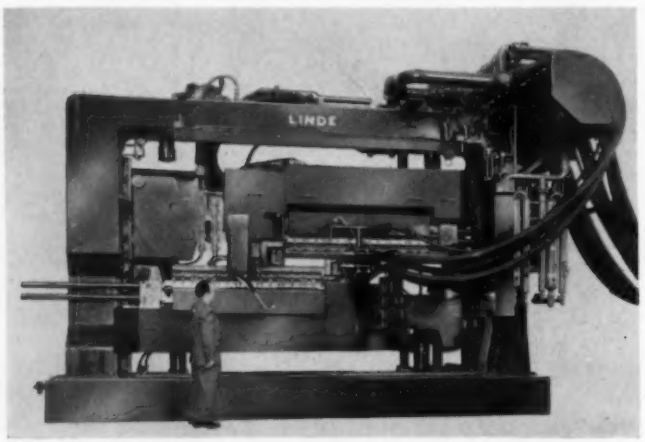


Figure 3 — All four sides of slabs up to 8½ in. thick and 75 in. wide are scarfed simultaneously by this machine.

turned on, the steel is preheated for a few seconds, and the roll table is started forward as the slag removal water and the scarfing oxygen are turned on to initiate the scarfing cut. By means of a second timer automatically energized, scarfing operation can be automatically terminated at any predetermined distance from the end of the bar or slab. This feature avoids scarfing scrap ends to be cropped later and protects the machine units from damage by split or distorted ends.

By proper selection of table speeds and cutting oxygen flows, it is possible to remove a uniform layer of surface metal of from $\frac{1}{32}$ to $\frac{1}{8}$ in. deep. This depth is sufficient to remove practically all surface defects, such as seams, checks, scabs, and roll marks. Practically speaking, however, it is not always economically advisable to scarf at depths necessary to remove the deepest defect. To secure maximum economy from machine operation, it is usual practice that each grade be scarfed to the depth which strikes the right balance between metal loss and processing costs on the one hand, and savings in reduced secondary conditioning and handling costs, on the other hand. Where direct rolling is practiced, the balance would be drawn between metal loss and processing costs on the one hand, and savings in reduced rejection loss on the other hand. The depth of the scarfing pass will vary with the different grades and types of steels processed, but the metal loss by weight is generally about 2 to 3 per cent of the product.

INSTALLATION RECOMMENDATIONS

An indication that the hot-scarfing process has become accepted as an integral and necessary part of most steel making is seen in the fact that many new mills have provided for scarfing machines while the mills were still in the drawing board stage. As a matter of fact, it is unusual today if new mills are not planned to include the hot-scarfing process. This is believed to be because experience has demonstrated clearly that it is most desirable to plan for a scarfing machine installation *before* a mill is built, rather than to attempt to fit a machine into a completed mill. During the planning stage, provision can easily be made to allow adequate space for machine-scarfing, even though no initial installation is contemplated. These provisions will make installation easier and less expensive in the future should changes in product or shifts in economic factors so warrant.

It has been found desirable to allow table length for two billets, blooms, or slabs in front of, and two behind, the scarfing machine. Naturally, this is the ideal arrangement, and compromises must be made, space-wise, in many instances. In this way, the scarfing machine will not interfere with the operation of the mill equipment ahead of it and, likewise, the piece of mill equipment following the machine, usually the shear, will not interfere with the operation of the scarfer. Provision should also be made for the erection of a control pulpit at a spot suitably close to the machine to house an electrical control unit as well as a gas control panel as shown in Figure 4.

The question naturally arises as to what is the best location for a machine in a given mill. While there is no stock answer to this question, it can be said that the majority of the machines now in service are located between the blooming or slabbing mill and the shear. Such a location is advantageous for several reasons: (1) only that portion of the steel which will be further rolled into products need be scarfed (the scarfing pass can be started beyond the crop end of the leading end, and stopped before the crop end of the trailing end), (2) one bar or slab of considerable length is scarfed instead of several sheared bars or slabs. In this way only one preheating cycle is required, and there is effected a saving in both the time and gases required for preheating.

By early planning for the scarfing machine installation, adequate table speed control, which is important if maximum flexibility of the process is to be obtained, can be provided. Although the depth of the scarfing cut can be controlled by varying either the table speed or the oxygen pressure, the greatest variation for efficient scarfing can be obtained through table speed control. Likewise, by early planning, adequate provision can be made for the necessary piping and wiring, slag and smoke-disposal equipment, suitable maintenance room, and other facilities.

By efficient scarfing, as referred to in the foregoing paragraph, is meant efficient metal removal as based solely on combined thermochemical and kinetic relationships. The usual measure of this efficiency is the "oxy-metal" factor, i.e. the number of cubic feet of oxygen consumed in removing one pound of metal. In hot-machine-scarfing this factor will vary between 1.5

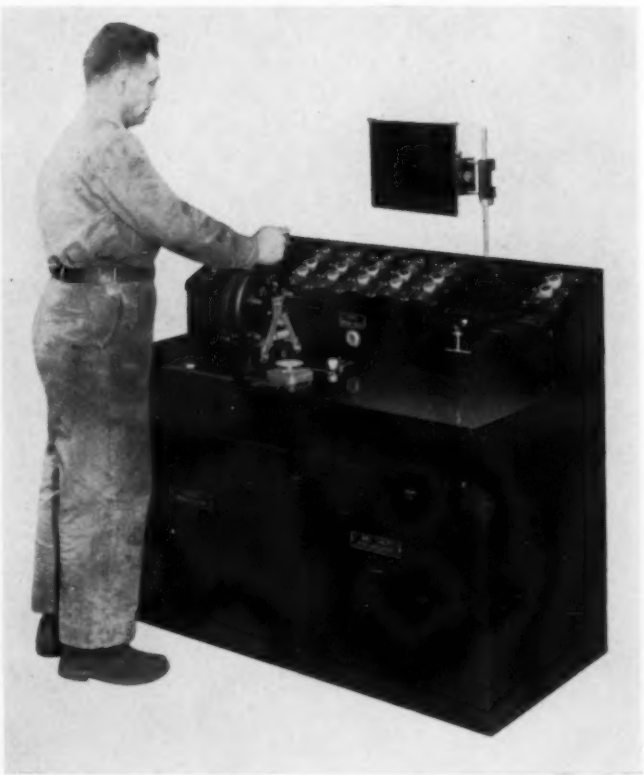
and 2.0 cu ft per lb under reasonably good scarfing conditions, and a value of 1.8 cu ft per lb is frequently used for estimating purposes. Some conditions which may appreciably affect this factor include: nozzle design, scarfing speed, preheat flames, angular relationship between nozzle and work, nozzle height and spacing, scarfing oxygen flow conditions, and temperature of the steel. As the nozzle design and the most efficient positioning of nozzles in a multiple nozzle scarfing unit are established in the original machine design, the two remaining important variables are the scarfing speed and the oxygen flow or pressure. Of these, the most important by far is the speed at which the steel passes through the scarfing machine. To cite an example of how important this speed is, one machine operating directly ahead of the first stand of a mill, scarfed products passing through the machine at the same speed as the mill. This speed was about 375 fpm, and was roughly three times the optimum speed employed at other machine installations. As a result metal removal was a bare minimum.

Original recommendations were that mill speed be adjusted so that scarfing could proceed at a normal pace. Heavier cuts could then be taken and the amount of secondary conditioning reduced, while still handling the full output of the blooming mill.

Validity of the recommendation was well proved when the speed of the stand was reduced to about 210 fpm. Backlog in the manual scarfing-yard was reduced sharply and a continuous flow of products through the plant was assured.

Variations in oxygen pressure outside of a relatively small range may introduce sizable increases in the oxy-metal factor. When optimum scarfing speed for a given depth of metal removal cannot be obtained, some compensation can be obtained by variation of the scarfing oxygen pressure or flow but only at some sacrifice of metal removal efficiency.

Figure 4 — Hot-scarfing operations are controlled by the electrical control unit shown here.



The foregoing discussion of scarfing efficiency is to a large extent of academic interest only, since oxygen costs are but a fraction of total scarfing costs. Fairly sizable variations in theoretical efficiencies usually correspond to relatively small changes in overall scarfing costs. The quality of the scarfed surface and the depth of cut are more frequently the reason for proper selection and accurate control of scarfing speeds and pressures.

In the past few years, air pollution and smoke cleaning problems have added new complexities to machine scarfing as to many other steel-making processes. The cleaning of scarfing machine smoke is admittedly a part of the general problem. Several companies specializing in air cleaning equipment have investigated the removal of color from scarfing machine smoke, and such companies should be consulted if air pollution is an important factor in new machine installations. Hot-scarfing smoke analyses indicate a gaseous composition essentially similar to that of air with solid material made up largely of iron oxides of submicron dimensions.

As larger scarfing machines were developed to meet the demands of the industry, the problem of supplying and controlling the large volumes of gases increased greatly. It is, of course, necessary for the proper operation of the mechanized hot-scarfing process to have available a constant supply of oxygen and acetylene to meet large and sharply fluctuating demands over unusually wide ranges. One of the larger desurfacing scarfing machines, for example, has an average hourly rate of oxygen consumption of but 40,000 cu ft. However, its maximum demand rate, during the scarfing cut, jumps to more than 400,000 cfhr. The development of these larger machines has been paralleled with the companion development of special regulators, valves and supply systems to handle such widely fluctuating gas demands.

IMPROVEMENTS IN THE BASIC PROCESS

In a paper entitled "Hot-Scarfing of Billets, Blooms, and Slabs," 1941 Proceedings AISE, p 260, the late E. A. Doyle discussed the hot-scarfing process and the machines available at that time. Since then, many process and machine improvements have been made. Some of the more basic improvements are discussed briefly in the following paragraphs.

The earlier scarfing machines employed a series of round-bore scarfing nozzles which produced a scalloped surface characterized by alternate ridges and fairly deep grooves. One of the earliest improvements in the process was the development of the slotted type nozzle, producing a series of flat scarfing passes, which blended together to produce an essentially flat, ridge-free surface. These early nozzles which burned pre-mixed preheat gases were subsequently replaced by post-mixing slotted nozzles which virtually eliminated the problem of flashbacks, thereby in turn reducing machine maintenance. This nozzle employs the same slotted cutting bore as the earlier slotted nozzle, but is designed so that the preheat gases mix at the exit end of the nozzle.

The elimination of pre-mixing gas mixers, paved the way for the development of a simplified scarfing unit assembly which did not include the old multiplicity of

preheat gas mixers and tubing. An important feature of the new scarfing unit is that a damaged unit can be changed in only half the time formerly required.

To improve the scarfed surface further, over that obtained with the multiple individual slotted nozzles, considerable time has been expended toward the development of a continuous-slot nozzle unit. The salient feature of this unit is that the cutting oxygen issues from it in a continuous flat stream to produce a completely flat scarfed surface, free of ridges or other surface discontinuity.

Piston-type selector valves provide a rapid and simple means for selecting the proper number of nozzles for the size of bar or slab to be scarfed. The selector valve is usually manually operated, but where frequent or large size changes are encountered, the selector valves, as well as the size adjusting mechanism, are motor driven. In addition, the larger machines are now equipped for remote nozzle selection and size adjustments. The operator makes these adjustments by means of push buttons located on the control table in the pulpit, and is guided by the group of indicating dials shown in Figure 5. These dials indicate at all times the size for which the machine is adjusted as well as the number of nozzles in use.

Figure 5 — Indicating dials on the control unit always show the operator the size for which the machine is adjusted and the number of nozzles in use.

In some mills having unusually fast rolling cycles, automatic billet positioning has been employed to reduce the overall time required for the scarfing cycle. In operating a machine with the automatic positioning feature, the operator has merely to depress the main scarfing switch as the steel approaches the machine. The entire scarfing cycle, from the positioning of the bar in the machine to the retraction of the scarfing units from the steel at the end of the bar, is electronically controlled.

FUTURE DEVELOPMENTS

Numberous scarfing machine developments are in the making. They should assist the steel industry to produce more steel faster, or better quality, and at lower cost.

One of these is experimental round bar scarfing, which should prove to be of value in the conditioning of seamless rounds. Laboratory test work has proved that hot-machine-scarfing of rounds will contribute materially toward the production of high quality seamless tubing.

The primary conditioning of hot stainless steel in the rolling line, while still in the final development stages, will soon be in production operation. As a result of extensive laboratory and field work, apparatus is now being designed to apply the powder-scarfing process to a standard hot-scarfing machine. Work accomplished to date indicates that the hot-scarfing of stainless steel will effect a considerable saving to the stainless steel producer over present methods of conditioning.

Flying starts by means of special powder starting developments should make possible in the near future the continuous passage of steel through the scarfing machine without need for the several seconds presently necessary for preheating before starting the scarfing cut. The automatic positioning, described above, coupled with flying starts and machine self-sizing means, currently under study, ultimately should make possible the completely automatic scarfing machine. It is expected with confidence that the above plans for the future, plus many other dreams too nebulous to record at this time, should result in the continued improvement of machine scarfing equipment to do a better job of handling today's scarfing problems and to meet new problems of the years to come.

DISCUSSION

PRESENTED BY

R. L. DEILY, Steel Mill Representative, Air Reduction Sales Co., New York, N. Y.

ANDREW HLIVKA, National Cylinder Gas Co., Chicago, Ill.

J. H. ZIMMERMAN, Manager Development and Process Service, Linde Air Products Co., New York, N. Y.

R. L. Deily: The need for mechanical scarfing machines in the steel industry becomes ever greater as all operating costs go up. Mechanical scarfing has made it possible for steel mills to produce high quality steel by direct rolling of ingot to finished bar with only a small per cent of the product needing secondary conditioning.

As was evident from Mr. Zimmerman's paper, the mechanical scarfer of today is a rugged mill machine which operates on the same schedule of availability as the rolling mills and tables with which it is integrated. As was indicated in Mr. Zimmerman's concluding remarks, in common with the rest of the development of American industry we are still not satisfied with what we have, and he has described some of the desirable mechanical scarfing developments that are now under study.

Figure 6 — In line unit is scarfing an 8 x 8-in. bloom.

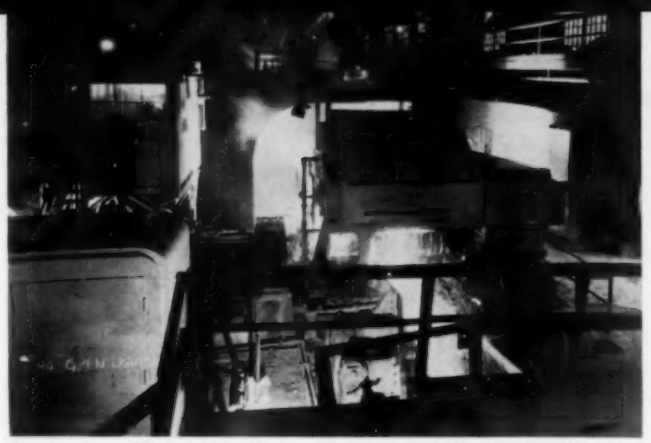


Figure 7 — This remote control variable size unit will scarf 7 x 7-in. to 14 x 14-in. blooms.

Figure 8 — This unit can be lifted out of the line for maintenance or repairs, when necessary.

Just for the purpose of adding a few further illustrations to the paper, the following figures show some standard mechanical scarfing machines, which my company has installed.

Figure 6 shows a simple, in line unit scarfing an 8 × 8-in. bloom, and is an overall view of a mechanical scarfing operation. Of course, as Mr. Zimmerman has pointed out, it is rather difficult to show very much about these scarfing machines in such action pictures.

Figure 7 shows a general view of a remote control variable size unit which scarfs 7 × 7 in. to 14 × 14 in.

Figure 8 shows a general view of a unit which is scarfing 8 × 8's, and which has as its features of lifting out of the roller line with a crane for routine maintenance.

Figure 9 shows a machine during manufacture, which is designed for scarfing either rounds or squares of approximately 8 in. size. This unit straddles the roller line. A dummy 8 × 8-in. piece is held in the scarfing head; the operating mechanism holding the scarfing head elevates, out of the roller line for routine maintenance and for scarfing head changes.

Figure 10 is a close-up view of the 8-in. square dummy in the scarfing head.

Finally, I am pleased to report that we have been successfully scarfing 8½-in. rounds with the machine shown in Figures 9 and 10, fitted up with the head shown on Figure 11. This operation of scarfing rounds is on a routine basis so far as the actual scarfing with this head is concerned. I might point out that the small orifices are for the preheating flames, and the larger holes are for the scarfing oxygen. This head is mounted on the arms that you saw in the previous Figure 10. By means of suitable mounting brackets it is possible to change from scarfing rounds to scarfing squares within a few hours. The total process, of which this round scarfing is an essential part, is still in the development stage, and as a result we are not free to discuss it any further at this time. When it is on a routine basis we hope to give you a complete description of the process.

Andrew Hlivka: In the mechanical conditioning is there any other fuel besides acetylene being used?

J. H. Zimmerman: To my knowledge all these machines are operating on acetylene.

Andrew Hlivka: Could other fuels be used?

J. H. Zimmerman: They can be used to a degree, but not to a sufficient degree. The flexibility of the process, depth of removal, and quality of surface is hampered considerably. We have not been able to produce performance equivalent to that obtained with acetylene.

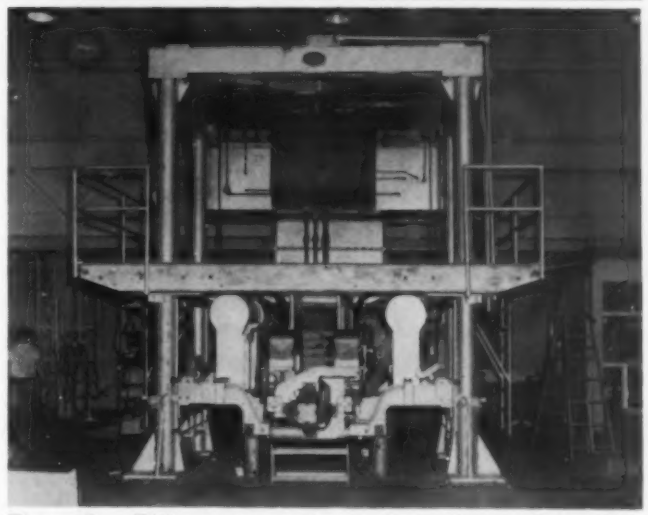


Figure 9 — Either squares or rounds can be scarfed on this unit.

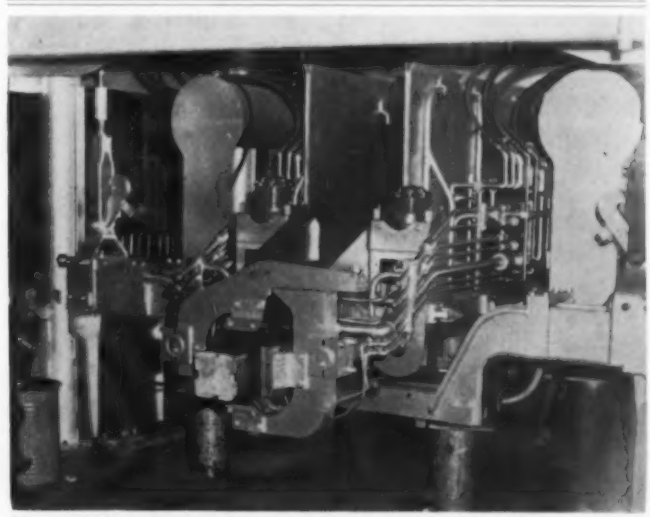


Figure 10 — An 8-in. square dummy can be here seen in the scarfing head of the unit shown in Figure 9.

Figure 11 — This head has been especially designed to handle rounds.

STEEL EXPANDS IN THE DETROIT AREA

. . . . extensive expansion and improvement programs are under way in the Detroit area . . . . papers describe status in the fall of 1952 . . . .

AT ROTARY ELECTRIC STEEL CO.

By ROBERT SERGESON
Chief Metallurgical Engineer
Rotary Electric Steel Co.
Detroit, Mich.

▲ THIS paper covers only the expansion in the Detroit area as related to the Rotary Electric Steel Co. Rotary being a relatively young company, I will trace its growth from its beginning. Rotary Electric Steel Co. was started in the depression year of 1933. Its name was chosen because the original objective was to exploit commercially a process for casting steel, melted in the electric furnace, under centrifugal pressure derived from rotating molds. Such a process eliminated the investment in equipment and operating expense involved in the orthodox method of casting steel ingots, reheating the ingots and rolling them into blooms, slabs and billets. This rotary casting process was not successful and was soon abandoned. Nevertheless the original corporate name was retained.

The present corporation took over the business on July 1, 1944. During World War II, Rotary, although small, was an important producer of high grade alloy steels which were in great demand for military uses. Those steels were sold in the form of ingots, billets, hot rolled bars and various kinds of cold drawn bars. When the war ended the demand for those particular products in alloy steels largely disappeared.

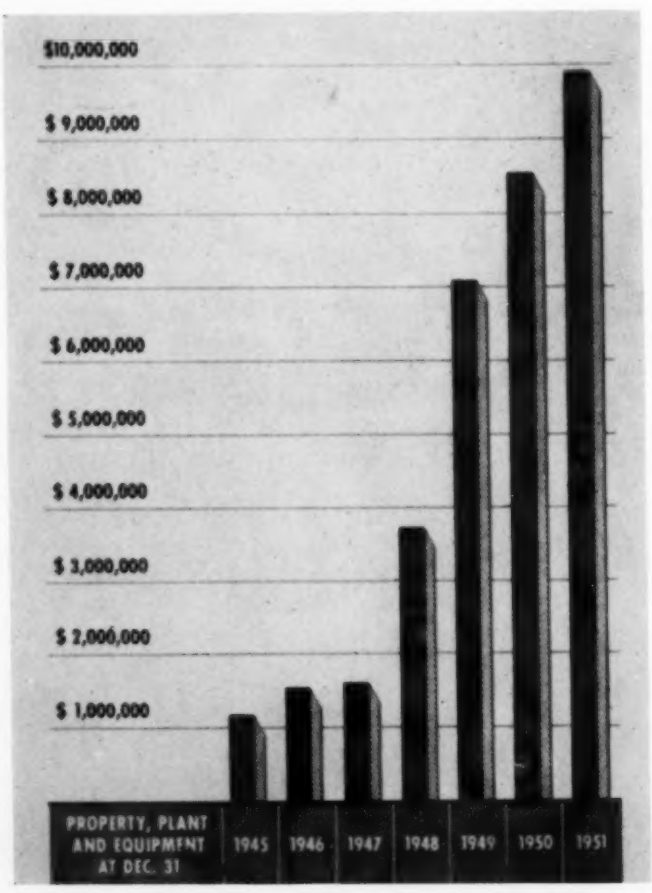
After the war the rapidly expanding requirements of the automobile manufacturers and other large users caused a severe shortage in steel sheets and strip. Since 1947, Rotary has supplied large tonnages of semi-finished steel for conversion into flat rolled products by other mills with a steady increasing emphasis on stainless steel. Over $10,000,000 has been spent since 1947 for expansion and improvement of production equipment.

When the present Rotary Electric Steel Co. bought its plant in 1944 it paid $621,000.00 for land, buildings and equipment. Today its property account stands approximately $11,000,000.00 less depreciation.

Figure 1 shows the increase in value of the company from 1945 to 1951 inclusive. Tables I, II and III show how the capacity and efficiency have been increased by this investment.

The Melt Shop—There are five furnaces, each rated at 60 tons capacity. Clam shell buckets are used for charging these five top charge furnaces. No hot metal

Figure 1 — In seven years, the value of the company has almost increased tenfold.



is employed in charge. The graphite electrodes are 20 in. in diameter, each section being 60 in. long. All five furnaces are basic lined and produce plain carbon, alloy steels, resulphurized steels and stainless steels. Since 1947 oxygen has been employed to reduce the carbon in the molten bath more quickly than previous method of using ore.

TABLE I

General	1944	1951
Land	30 acres	41 acres
Ground area of buildings	320,000 sq ft	451,000 sq ft
Railroad track (standard gage)	3.03 miles	3.85 miles
Steam locomotives	3	1
Diesel locomotives	..	3
Freight cars	21	37
Electric cranes	23	30
Yard cranes — steam	2	1
Yard cranes — diesel	..	2

TABLE II

Melt shop	1944	1951
Electric furnaces		
Side charge	2	..
Top charge	..	5
Total rated capacity, per year	160,000 net tons	425,000 net tons
Transformer capacity, per furnace	10,000 kva	16,000 kva
Blooming mill		
Size (center to center of rolls)	28 inches	36 inches
Motor drive	1500 horsepower	4000 horsepower
Maximum width of product rolled	16 inches	44 inches
Capacity per month (3 shifts)	12,000 net tons	60,000 net tons
Man-hours per ton rolled (average sizes)	1.25	0.41
Pre-heating facilities	6 batch-type furn's	8 soaking pits
Oil consumption per ton of blooming mill product	29 gallons	8.5 gallons

TABLE III

Billet mill (none until 1951)	1944	1951
Number of stands	..	4 (plus vertical edger)
Size of stands		22 inches
Motor drive		4250 horsepower
Length of cooling bed		84 feet
Capacity per month (3 shifts)		60,000 net tons
Bar mill		
Number of stands	5	10
Size of stands	18 to 12 inches	21 to 12 inches
Motor drives	1300 horsepower	5100 horsepower
Length of cooling bed	105 feet	160 feet
Capacity per month (3 shifts)	12,000 net tons	18,000 net tons
Number of men (exclusive of reheating furnace)	40	17
Man-hours per ton rolled (average sizes)	4.0	0.8

The Detroit Edison Co. feeds 24,000 volts alternating current to our primary transformer, which in turn, feeds four 16,000-kva transformers (furnaces 2 through 5) and one 15,000-kva transformer (furnace 1), the melting voltage being 300 volts.

We are now changing from clay hot tops to the permanent type hot tops. This change is however too recent to have any comparative data, but appears to be in the right direction.

Chemical Laboratory—For the past two and one-half years we have employed one direct reading—spectroscope, which operates in 44 seconds, 14 seconds for pre-spark and 30 seconds for exposure, marking the receiving clocks in linear calibration, which is then converted into actual element concentration. Reports of results are relayed back to melt shop within a period of 8 minutes.

Volumetric carbon and sulphur determinators and a 400 ft length pneumatic tube enables laboratory to receive, promptly determine and relay test results. One teleautograph machine is employed to report results to melt shop.

Soaking Pits—Six pits are of single burner, center bottom-fired, with recuperators design. Pits 7 and 8 use top-fired burners with no recuperators. All pits use No. 5 fuel oil. Each pit is 13 ft by 17 ft, with depth of 10 ft.

Blooming Mill—This is a 36-in. two-high reversing blooming and slab mill, using 36 x 78-in. long rolls. It is powered by a 4,000-hp motor, operating at 700 volts and 50/120 rpm. This mill usually will roll down to 6 x 6-in. billets. To roll below this size consumes too much time.

Hot Scarfing Machine—The hot scarfing machine was designed to desurface the four sides of blooms simultaneously. Table speeds range from 70 to 210 fpm and the machine will desurface material from $\frac{1}{32}$ to $\frac{3}{32}$ in. in depth. Material size ranges from 4 to 10-in. width to 2 to 10-in. thickness. Approximately 200 cu ft oxygen and 10 cu ft acetylene are used for each ton of steel processed. This machine will desurface a 55 ft length, 6 x 6-in. bar in 40 seconds.

Blooming Mill Shear—This shear is a 770-ton capacity, open side down-up-cut design, powered with two 250-hp direct current motors. Each motor has its own generator. The shear is capable of 16 cuts per minute.

Billet Mill and Hot Saw—This mill consists of four two-high continuous stands with 22 x 51-in. long rolls. These four stands are powered by two 2,000-hp synchronous motors at 300 rpm through two reducers. The vertical edger between stands No. 2 and 3 is driven by a 250-hp direct current mill motor. This mill will roll slabs 2 to 4 in. thick by 8 to 16-in. wide and 3, 4 and 5-in. billets. Other sizes can be obtained by change in roll design. The hot saw is driven by a 300 hp, a-c motor, traveling approximately 22,000 peripheral fpm and will hot saw steel up to 8 x 8-in.

A 35-ft wide by 84 ft long hot bed extends into chipping building.

Bar Mill Furnace and Bar Mill—A pusher type furnace with a 53 ft x 17 ft hearth handles billets 2½ in. to 6-in. square x 15 ft long. There are three banks of seven self-proportioning oil burners, two above the hearth and one below. The burners use No. 5 fuel oil.

The 10-stand mill produces bar stock ranging from ½ to 4½ in. inclusive. Number 1, 2 and 3 stands are two-high roughing stands with 21 x 42-in. rolls and are powered directly through two reducers by 900-hp 600-volt, 200/600 rpm direct-current motor. Stands 4 through 6, use 18 by 36-in. rolls. Number 4 is driven by a 700 hp 270/540 rpm direct-current motor, while stands 5 and 6 are driven by two series connected 700-hp, 270/540 rpm direct-current motors through a reducer. Stands 7 and 8 use two high housings and 13 by 20-in. rolls. Their drive is similar to that for 5 and 6 stands. Number 9, a three-high stand and number 10, a two-high stand, use 13 by 20-in. rolls. They are driven by one 700 hp, 270/540 rpm direct-current motor.

The flying parting shear is used to cut bars, to hot bed length, that have been rolled to less than 1¼ in. in diameter.

The mechanical hot bed, 20 ft wide by 160 ft long is divided into two sections with variable frequency run in rolls.

Conditioning—For conditioning the following equipment is employed:

One mechanical chipper, equipped with eight interchangeable tool heads and driven by 30-hp, d-c motor.

Thirty-four grinding machines, driven by 20-hp, a-c motors and using a 20 x 8-in. x 2½ in. abrasive wheel mounted in a swing frame.

Eight automatic grinding machines, driven by 20-hp, a-c motors and using a 20 x 8-in. x 2½ in. abrasive wheel mounted in the hydraulically controlled frame. These machines are expected to replace the swing frame grinding machines in a ratio of 2½ to 1.

DISCUSSION

PRESENTED BY

HARRY W. CLARK, Ford Motor Co., Dearborn, Mich.

ROBERT SERGESON, Chief Metallurgical Engineer, Rotary Electric Steel Co., Detroit, Mich.

Harry Clark: How much gain in carbon drop do you obtain with oxygen? Do you also use oxygen in conjunction with ore?

Robert Sergeson: We are using a little ore with the oxygen. In fact, it is beneficial to have ore added when you use the oxygen. We use it on our rim steel and stainless.

Harry Clark: Where do you start oxygen? On any specific carbon, say below 50?

Robert Sergeson: It is usually when you want to drop about ten points in carbon on your rim steel and on your stainless you start it when you are about melted.

AT GREAT LAKES STEEL CORP.

By H. L. KLINKER

Assistant Chief Electrician

Great Lakes Steel Corp.

Ecorse, Mich.

▲ EVERYONE remembers the clamor for steel at the conclusion of World War II. The entire industry was called upon to produce every pound of steel possible. As the auto and appliance manufacturers and all other fabricators got back into civilian production, it became apparent that the only solution to the problem was rapid expansion of production facilities. In this program the Detroit area has kept pace with the industry.

To explain the Great Lakes Steel Corp's. contribution, I feel it necessary to start with its organization by George R. Fink, 23 year ago.

The initial physical problems was location. An abundant water supply was essential to plant operation. Access to water transportation of raw materials was an economic necessity, and proximity to the rolling mill previously established by Mr. Fink in Ecorse was desirable. The answer to these needs was found at a seemingly impossible site, a swampland bordering the river at Ecorse. Engineers accepted that swamp's challenge. Surveying operations were carried out from row boats. A hundred thousand piles were driven down to bedrock 75 feet below the surface. And on these pilings was erected a modern steel plant.

Great Lakes' growth is unique in the industry in that it has been a virtually continuous expansion since establishment. Much of the investment involved has been in anticipation of the needs of its major customer, the automotive industry. And thanks to this foresight, many an automobile which otherwise could not have been produced is on the highways today.

Great Lakes' initial facilities consisted of six 150-ton open hearth furnaces, a 40-in. blooming mill, 21-in. bar and billet mill, a 34-in. continuous strip mill and two merchant bar mills—plus the necessary finishing departments and service shops. This unit had an unusual capacity of approximately 750,000 tons of steel ingots. I would like you to remember this figure for comparison later.

As early as 1934, the company began to expand, building two more open hearth furnaces. In 1935, the first major expansion took place with the construction of a 96-in. continuous hot strip mill, three continuous picklers, two 3-stand cold reduction mills and the necessary annealing, skin pass and shipping facilities.

At the completion of this program, four more open hearth furnaces were added to the No. 1 shop, making a total of 12. Along with the open hearth additions, the reheating capacity of the soaking pits was more than doubled.

The summer of 1937 again found construction crews active at Great Lakes Steel, and in the spring of 1938 the first ingot was rolled on a new 46-in. blooming mill. This signalled the completion of the second major expansion which also included the erection of the No. 2 open hearth shop, consisting of four 200-ton furnaces and the necessary additions to the soaking pits.

This brought us to the years of World War II, during which a plate line for processing armor plate was installed. The smoke of the war had hardly cleared away when Great Lakes Steel undertook further expansion. First on the program was the erection of a fourth reheating furnace for the 96-in. strip mill.

A third major expansion was then undertaken to provide additional cold reduction, annealing and finishing facilities. The end of 1947 found this program well on its way toward completion. December of that year saw the first operations of the No. 3 tandem mill, a giant capable of cold reducing 90-in. material at speeds up to 1500 fpm. The old skin pass mills had all been re-located in one of three new buildings erected during this period. Two new skin pass mills were also installed. The annealing and shipping departments were doubled in size. As part of this program, 4000-hp motors and the necessary generating equipment were ordered to modernize the No. 1 tandem mill, giving it a rating similar to No. 3 mill. However, due to the necessity of keeping every production unit operating at this time, this part of the program had to be postponed. It was finally completed in March and April of 1952.

This increased rolling capacity brought a demand for more steelmaking facilities. This was accomplished by enlarging nine of the present open hearth furnaces to 500 tons capacity each and the erection of a new 500-ton furnace at the No. 2 shop.

The beginning of the Korean "mess" brought an even greater demand for steel, that of trying to supply the already growing defense needs and the civilian economy combined. In fact, the demand became so great that we heard threats from Washington to put the Government in the steel business.

Once again Great Lakes Steel began to expand. The Zug Island blast furnace plant, which had kept pace with the expanding steel plant by the addition of a 1200-ton furnace, the enlargement of one of the older ones and the erection of a complete coke and by-product plant, was again enlarged by the addition of a fourth blast furnace.

This 480,000-tons-a-year furnace—one of the largest ever built, was lighted Sept. 22, 1952. Its installation required new storage yards, docks and unloading facilities to handle raw materials. Additional coke ovens are now being built.

Work also is now progressing on the erection of a 45 x 90-in. universal slabbing mill. The hoped-for completion date is late spring or early summer of 1953.

These have been the major programs at Great Lakes Steel. Since the war, many smaller but no less important installations have been made. They include two bessemer converters at the No. 1 open hearth shop, a 36-in. continuous pickler at the 34-in. strip mill, speeding up the three old picklers, new and larger coilers at both strip mills, and the site is now being cleared for the erection of two more bessemers at the No. 2 open hearth shop.

With the completed additions and those under construction at the present time, Great Lakes maintains its high ranking among the nation's major steel producers, and by 1954 will achieve a capacity of 3,500,000 ingot tons annually.

AT FORD MOTOR CO.

By A. KRAUSE
Manager Rolling Mills
Steel Division
Ford Motor Co.
Dearborn, Mich.

▲ IN 1947 the Ford Motor Co., facing an ever increasing demand for its products, embarked upon a vast expansion program to maintain its competitive position in the automotive industry. Finding our steel division in somewhat of an antiquated position to maintain a competitive cost position, as well as a relative productive ratio, it was necessary to increase our capacities to meet these new demands. This is our story.

Before reporting on the Ford Motor Co's. contribution to the steel industry in the Detroit district, we should state the Ford Motor Co's. position relative to the increased capacities accomplished since 1947. We do not consider our increased capacities the result of plant expansion, but one of modernization and rearrangement instead, as most of our modernization has taken place within existing plants, and in no case outside of the present mill sites. Roughly, 500 acres were devoted to coke, iron and steel production in 1947. Since then some of this space has been abandoned in favor of the automotive divisions.

Although we have completely integrated iron and steelmaking facilities, we produce a limited scope of steel plant products which are for our own use, or assigned to the defense program on allocations.

Some of the principal facilities that will be described are either in operation, under construction, or have been committed. The final date for completion of this program is slated in the fall of 1953.

TRANSPORTATION

New Great Lakes Ore Carrier—A new ore freighter is now under construction. It will be named "William Clay Ford." The overall length is 647 ft breadth 70 ft depth 36 ft. Cargo capacity is 19,825 long tons. The shaft horsepower is 7,000 and the speed loaded is 16 mphr, speed light is 19 mphr. The fuel is bunker oil, and the main propulsion is a turbine. Cost is $6,000,000. Completion date is August 1, 1953. This will add a substantial carrying capacity to the present freight of 850,000 gross tons of ore and limestone per year.

Approximately 6,150 tons of steel are being used in the hull construction.

The Ore Docks—Modernization and relocation of dock space is now in process. One new coal unloading bridge has been added, and a new dock unloader for coal and ore is also in use.

COKE PLANT

Thirty-seven new ovens have been added to augment the present 183. A new blast furnace coke screening

station is under construction. Two new ammonia stills, new spray type saturators for ammonia sulphate, new benzoil scrubbers, and new naphthalene and pyridene recovery have been added for increased byproduct plant capacity.

BLAST FURNACES

One 27½-ft hearth blast furnace, rated at 1500 tons per day, has been built, and is now in operation. A new sintering plant, rated at 1500 tons per day, is now under construction. A new 65-ft thickener is to be installed. One new 100,000-cfm turboblower has been installed and one more has been committed. Eight 150-ton mixer type hot metal cars are replacing some open top ladles.

OPEN HEARTH

Complete modernization of the open hearth has consisted of the removal of three 110-ton tilting furnaces, and replacing them with three 200-ton stationary. In addition, one 180-ton tilting furnace has been rebuilt to a stationary, and the rebuild of another 180-ton tilting furnace will be completed by 1953.

Complete modernization of ingot stripping and scrap handling facilities are now in progress. Rearrangement and modernization of the mold building is committed. A new skullcracker and slag dump is now in operation.

Two new charging machines are committed. One new hot metal ladle crane is now in operation.

Modernization of the open hearth stock house is in process. Modernization and rearrangement of the ore, limestone and refractory bins are committed.

This modernization and rearrangement of open hearth facilities has increased ingot capacity which in 1947 was 70,000 tons to 115,000 tons per month.

SOAKING PITS

Complete modernization of the present soaking pit facilities, which includes the replacement of the present pits with 20 new 8-ft by 25-ft recuperative pits is now in progress.

Replacement of two of the present tong cranes for larger ingots is now committed.

BLOOMING MILL

Modernization of the blooming mill for larger ingots is committed. One slab scarfer and two bloom scarfers are in operation. Additional equipment for transfer of hot slabs to the hot mill is in operation.

HOT STRIP MILL

One additional slab heating furnace is under construction. Auxiliary equipment to depile and stack slabs is under construction. Replacement of the No. 1 scale breaker by a 66-in. unit for rolling 60-in. straightaway is under way. The replacement of the present coilers with mandrel type coilers is now under construction. One new descaling pump is now in operation. Rearrangement of roll grinding facilities are in progress. A new hot coil conveyor is under construction.

We are also completely rebuilding three pickle lines, adding trimming equipment, plus new conveyors for 50,000-lb coils.

CHANGES IN COLD ROLLING DIVISION

66-in. three stand tandem cold mill — Complete modernization with increased speed and compensating horsepower to roll coils of 840 lb per in. of width to 60-in. wide.

84-in. Cold reversing mill—Complete modernization of uncoiler and reels for processing 840 lb per in. of width coils.

In addition we are installing a complete new conveyor system throughout the cold mill.

Coil annealing—Modernization, replacement and relocation of existing cold rolled bright annealing equipment to handle coils of 66-in. outside diameter.

Cold roll finishing—Complete modernization of our 84-in. 4-high temper mill to handle 50,000-lb coils is in process. Replacement of the present two, 2-high 56-in. temper mills with one 66-in. 4-high temper mill is now in process.

Complete modernization of two existing flying shears for 50,000-lb coils is committed. One new 60-in. high-speed slitter and modernization of the present 78-in. slitter is committed. In addition, our program calls for the rebuilding of five existing cranes, and the replacement of four in the cold mill.

Through rearrangement and modernization, we have increased our shipping facilities. In addition employees wash and locker rooms are being expanded throughout.

This completes our list of the principal part of the Ford Motor Steel plant modernization program which will be accomplished at an outlay of $54,000,000 and will have increased our capacities in the major units as follows:

In 1947 production of:		In 1953 planned capacity is:
Coke was	1,057,257 tons	1,500,000 tons
Iron was	497,436 tons	1,200,000 tons
Ingots was	945,238 tons	1,600,000 tons
Hot strip mill	621,225 tons	1,400,000 tons
Cold rolled	391,192 tons	780,000 tons
Flat rolled	758,261 tons	1,200,000 tons

In conclusion we would like to point out that this modernization has only put the steel division at Ford's in a position to maintain its same ratio of supply that existed prior to 1947 in comparison to the steel industry.

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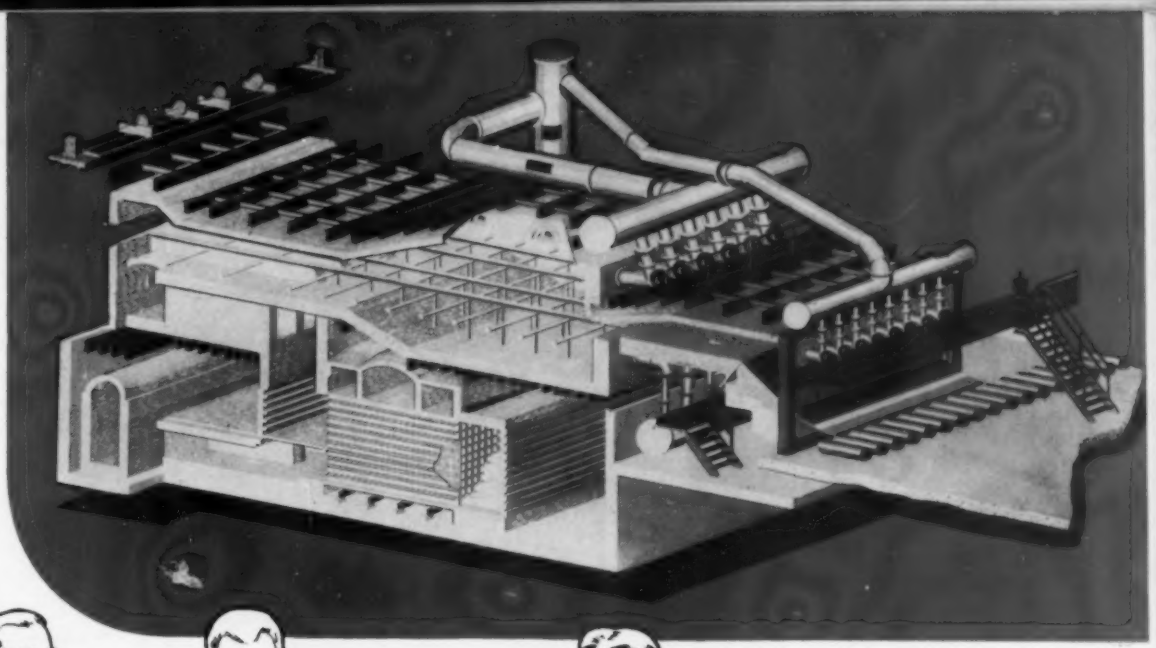

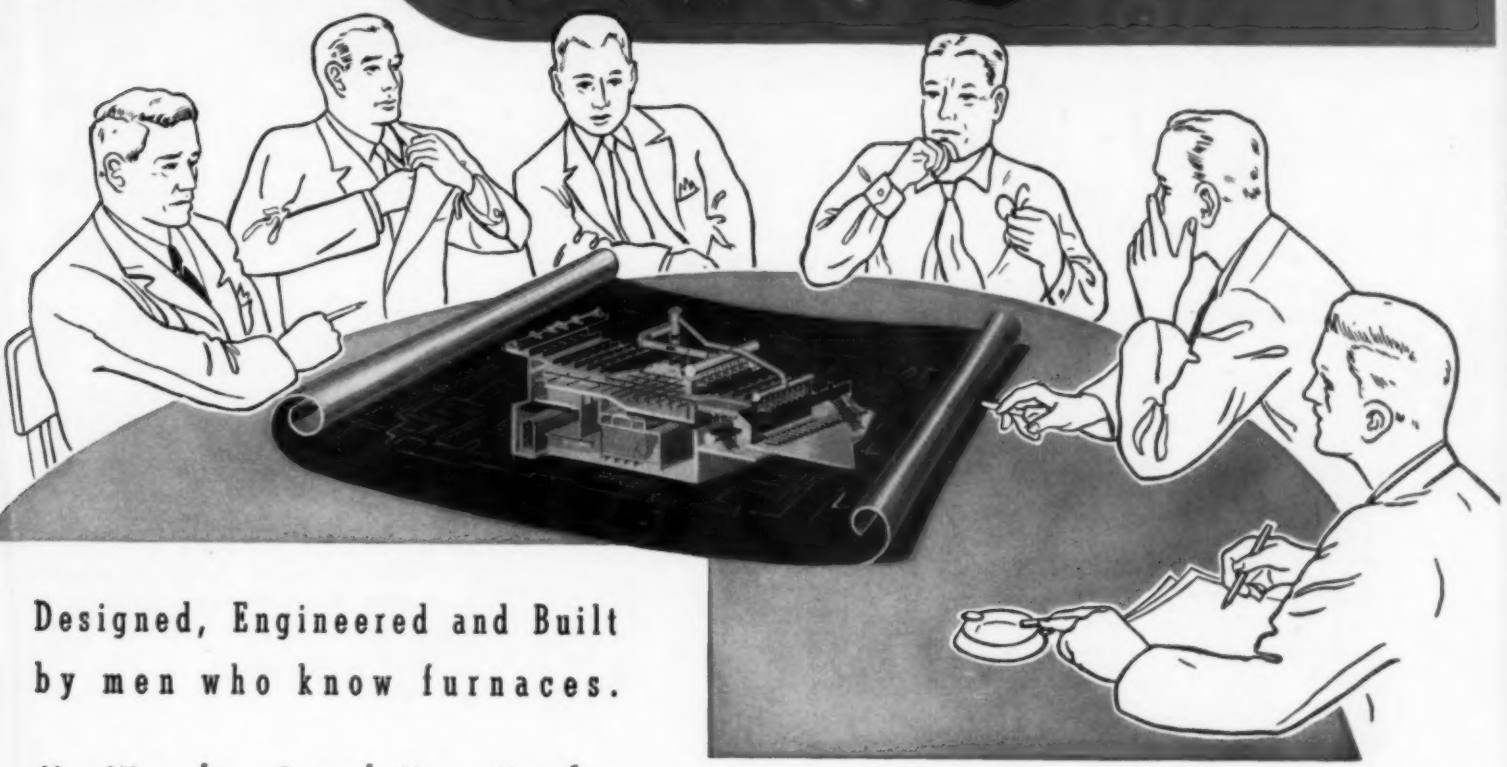

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F-9

NATIONAL SURVEY SHOWS BROAD RANGE IN FOREMEN'S PAY AND DUTIES

▲ NEW light on foremen's responsibilities and earnings in both manufacturing and non-manufacturing industries is cast by a pilot study of foremen's salaries prepared by National Foremen's Institute, New London, Conn. Based on returns of 10,000 questionnaires compiled by that organization, the study demonstrates the differences in rank and pay which go with the title — indicating an urgent need for better job evaluation in the middle management brackets.

Salary data compiled from this research reveals a range from less than $300 a month to over $700 for what the Institute calls "Class I" foremen in the manufacturing field, with 48.1 per cent earning between $450 and $525, while almost 80 per cent of those grouped within Class II earn between $375 and $450. In non-manufacturing, the pay checks are smaller — 74.4 per cent of the upper groups are paid $375 to $475, while 68 per cent in Class II earn between $300 and $400 a month.

Job-descriptions emerging from the survey reflect, without exactly paralleling, these differences in earnings. The job title of "foreman," is apparently all things to all men. In one company the foreman may be a veritable "small business man" running his department virtually on his own. He may have a heavy hand not only in production planning, but also in budgeting, purchasing and other facets of organizational planning. His authority may extend to having the last word in hiring and firing, transfers, promotions and demotions. To all intents and purposes such a foreman is "boss."

At the other extreme, a foreman may be little more than a monitor with authority so watered down as to make his managerial status an empty title.

In the manufacturing field, the typical Class I foreman usually has years of experience and works under the general direction of the plant superintendent or general foreman. He may supervise workers on more than one shift or in more than one area of the plant. He determines procedures of work, and devises manufacturing processes and toolings; is responsible for maintenance and repair of equipment, and may be authorized to purchase equipment, material and supplies. Such a foreman may employ, train and discharge workers, as well as assign duties, and may initiate rate changes, employee transfers and disciplinary action. He may also keep time, production and other clerical records, including those dealing with personnel.

The Class II foreman, in contrast, ordinarily supervises men on one shift and in one work area, and the work supervised is not of as complicated a nature as that directed by Class I. It is usually repetitive in process. He assigns work in line with field work schedules, and when he trains new workers he commonly uses a training outline prepared by others. He requisitions supplies and materials in accordance with specifications set up by others, and refers matters of promotion, leaves of absence and discipline, with recommendations, to his superior. The Class II foreman usually has fewer years of experience than Foreman Class I, but may be in training for a Class I job.

In non-manufacturing fields, the Class I foreman commonly directs the work within a particular department or establishment and assists in formulation of policies relating to the selection, training, promotion, salaries, recreation and discharge of employees. He executes these policies directly or through subordinates, and is responsible for the profitable functioning of his organization. Other responsibilities include maintaining harmonious working relations among personnel, ensuring cooperation with other departments, maintaining records of attendance, production and efficiency, and supervising inventory. The Class II foreman in the same fields performs similar duties, but under supervision and in accordance with instructions.

The number of employees supervised by foremen varies with the size of plant, the Institute's survey shows. The average Class I foreman in plants with over 1000 workers direct 48 employees. In smaller installations with under 100 workers, the foreman has charge of an average of 20 workers. The national average of workers supervised per Foreman Class I, all industries, is 37 subordinates, ranging from 44 in the Northeast to 25 in the South. For Class II foremen the national average is 22, and the range is from 28 in the Northeast to 19 in the South. The survey report also reveals the salary ranges, by area, for both classifications of foremen.

The survey, the first of its nature to be conducted on a nationwide scale, was undertaken to determine whether top management regards the foreman as a key individual, or whether it is merely giving lip service to his importance. "Pay-wise," A. C. Croft, president of the Institute, declared, "survey results prove that foremen are obtaining a substantial differential over and above the take-home pay of hourly employees. In most cases the foremen earn from ten to 25 per cent more than do the best-paid people whom they supervise. But there still is much to be done in standardizing the duties and responsibilities which make up the foreman's job."

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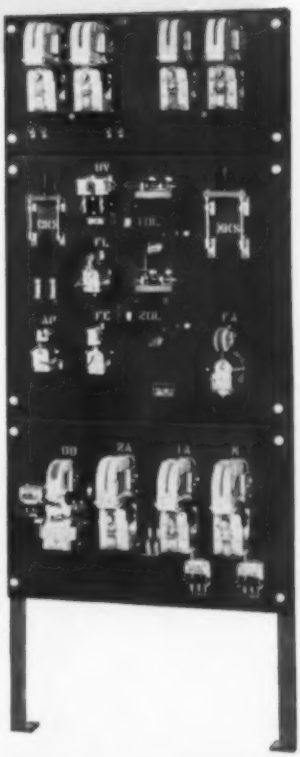

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MODERN OUTLET TABLE INSTALLED ON PIERCING MILL

▲ AT a cost of $76,800, the Steel and Tube Division of the Timken Roller Bearing Co. has installed a modern, and what has proved to be, highly efficient outlet table on its Number Two piercing mill. The new table, equipped with roller guides which hold the mandrel bar and pierced tubing rigidly and accurately in position for the precision piercing, replaces a standard Mannesmann outlet table. These roller guides, made of Graph-Mo steel, resist nicking or pitting and are self-polishing. Since the roller guides are subjected to extraordinary wear, they are mounted on Timken tapered roller bearings.

A series of three guides which holds the tubing in proper alignment, are opened and closed to admit the pierced bar and tubing by means of compressed air units. The roller guides not only the mandrel bar firmly but also the tubing. After the timing device opens to admit mandrel bar and tubing, both are under the firm control of the roller guides. On the old mill, the mandrel bar was not firmly controlled, and even when the old style guides were adjusted to control tubing and mandrel bar, a considerable tolerance, or uncontrolled movement of tube and bar existed.

A compressed air valve on each guide is actuated by electric current, which is in turn controlled by a series of three clock-type timers. These timers, located at a control booth at the side of the outlet table, are set in such a manner that as the pierced tube is being delivered out of the piercer rolls, it strikes a trigger which sets the timer in the control booth to running. By using a trigger, which is set off when contacted by the tube, Timken Co. engineers believed that there would be less chance for mechanical failure than if an electric eye were used to start the timing devices. Subject to constant, heavy vibrations, and the dirt and dust of the mill, the mechanical features of both the piercing mill and the outlet table must be able to withstand such conditions.

Since the speed of the piercing operation is dependent upon the feed angle of the work roll and the speed of the work roll itself, the timers, when set to accommodate a particular order, must be adjusted accordingly. The task of changing the angle and speed of the work roll is that of the plugger. His work is carefully checked by the piercing mill foreman.

The first timer, upon the release of the trigger, and after a pre-set lapse of time, will actuate the solenoid valves of the first guide. Then, in proper timed sequence, the number two and number three guides open to admit the pierced tube, holding the tube in a firm and controlled position on the outlet table. After the tube has been pierced, the solenoid valves release the guides, and the tube is then stripped out on the outlet table and delivered onto a conveyor for the finishing process.

After a tube has been discharged onto the conveyor, the process begins all over again; roller guides are reset for the next tube, timers are reset, and trigger is cocked, ready to receive the next billet.

The new outlet table has resulted in better control of the entire piercing operation. Flexibility has been increased since the new outlet table adjusts itself to a wider range of sizes. Safety of operation has been greatly increased, since the mandrel bar is held rigidly in place making it virtually impossible for it to buckle. Concentricity control has been greatly enhanced, making it possible to adhere to the high specifications which are required of Timken Co. products.

The installation of the modern outlet table is expected to substantially enhance the quality of tubing produced at the Timken Co.

Figure 1 — Guides are shown closed on tube and mandrel bar.

Figure 2 — Guides are shown open, with pierced tube ready for discharge off the outlet table.

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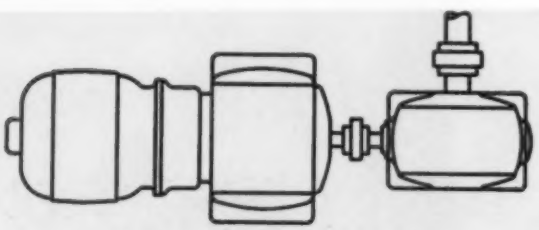
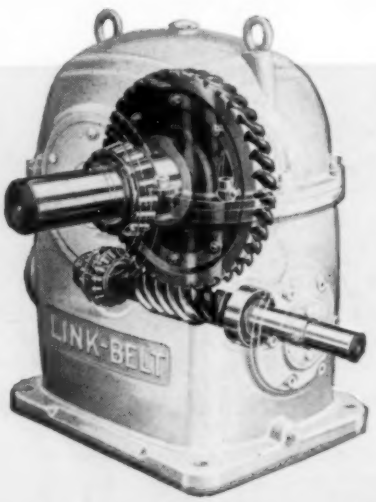
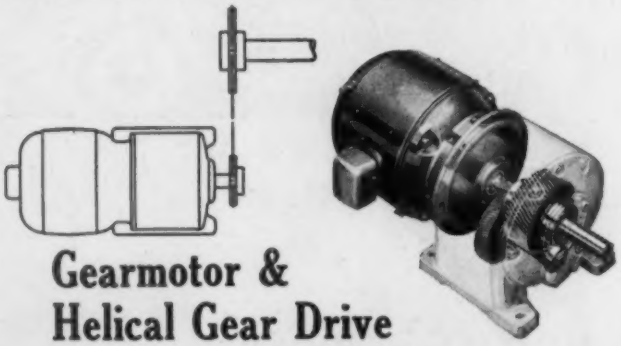


Worm Gear Drive

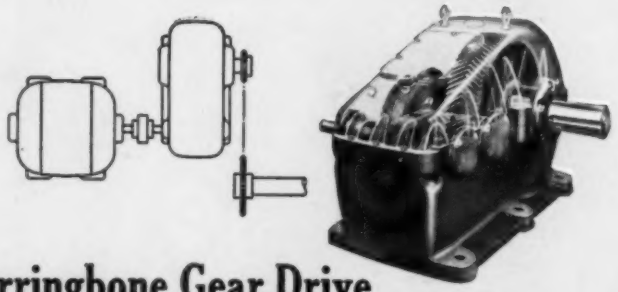
WORM GEAR and P.I.V. variable speed drives are shown direct-coupled. Link-Belt worm gear drives are available in 3.1:1 to 8000:1 reduction ratios—1400 to 123,000 in. lbs. torque—0.22 to 564 output shaft rpm. Ask for Book 2324A.





Gearmotor & Helical Gear Drive

GEARMOTOR is shown with roller chain drive. Link-Belt Helical Gear Drives, Gearmotors and Motogears are available in 6.2:1 to 292:1 reduction ratios—1 to 30 hp—6 to 280 output shaft rpm. Ask for Books 2247 and 2451.



Herringbone Gear Drive

HERRINGBONE GEAR DRIVE is shown connected by flexible coupling to motor and with roller chain takeoff. Link-Belt Herringbone Gear Drives are available in 2.84:1 to 326:1 ratios—0.4 to 2480 hp—2.2 to 623 output shaft rpm. Ask for Book 2519.

GRANITE CITY STEEL STARTS NEW BLOOMING MILL

▲ THE new 46-in. blooming mill at the Granite City Steel Co., Granite City, Ill., has been completed and went into full operation the week of April 6. The first ingot was rolled into the new mill late the previous week.

Completion of the blooming mill marks a major achievement in Granite City's current $68,000,000 expansion and modernization program. This new mill, along with its auxiliary facilities, accounts for about 40 per cent of the total expansion budget. The $68,000,000 expansion program was launched in 1951 and is designed to double Granite City's total capacity. The program is scheduled for completion by late summer.

Construction of the new blooming mill started in March, 1951. The mill is the most modern and efficient in the steel industry and rates with the largest of its type. Adjacent soaking pits, slab storage and scarfing facilities are also completely modern.

The new soaking pits are fully automatic and consist of six "three-hole" pits, each with an opening measuring 46 by 150 in. and having a capacity of 100 tons of ingots. These soaking pits heat ingots to a rolling temperature of about 2200 F.

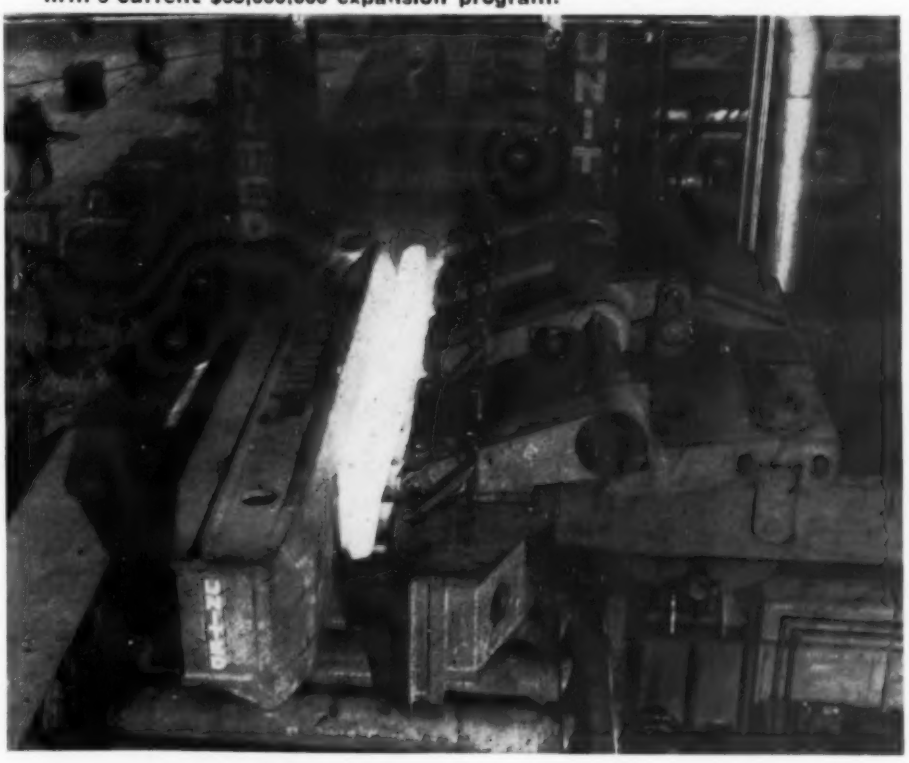
The new blooming mill is powered by two, 5,000-horsepower twin-drive electric motors. It is capable of edging a slab up to 66 in. wide, maximum size found in the steel industry. A new slab shear cuts hot slabs up to 10 in. thick and 60 in. wide. The mill is housed in a new building with a ceiling height of 79 ft., equivalent to a seven-story structure.

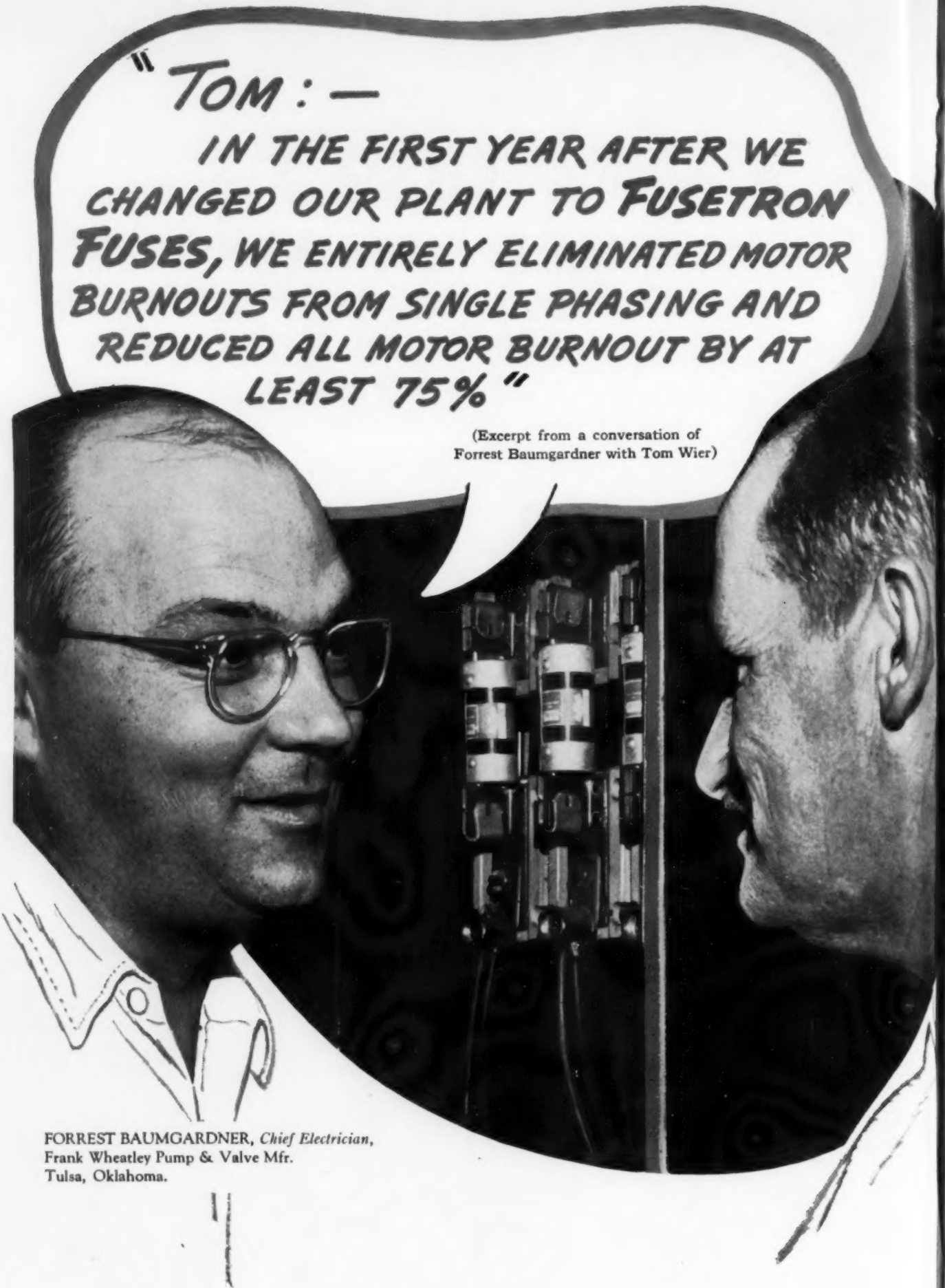
Granite City Steel's new mill will replace the old slab mill which was located in the hot strip department. The new installation not only has four times the potential capacity of the old mill, but can also perform many jobs which are impossible on the old slab mill. Most important is the ability to roll blooms.

Company officials stated recently that the old slab mill will be shut down one week after the blooming mill started full operation. However, the mill will not be fully integrated into company operations until mid-summer when the new open hearth furnaces go into production.

Three new 300-ton open hearth furnaces are major items in the Granite City Steel expansion program. Other major projects in the multi-million dollar program are three new slab furnaces, a new roll maintenance building, a hot strip roughing mill, a hot strip shear line and 27 new coke ovens.

Figure 1 — View of a portion of Granite City Steel Co.'s new blooming mill shows steel slab being turned by manipulators for further rolling. The new mill, only kind of its type in the St. Louis area, accounts for 40 per cent of the steel firm's current $68,000,000 expansion program.




"TOM:—
IN THE FIRST YEAR AFTER WE CHANGED OUR PLANT TO FUSETRON FUSES, WE ENTIRELY ELIMINATED MOTOR BURNOUTS FROM SINGLE PHASING AND REDUCED ALL MOTOR BURNOUT BY AT LEAST 75%"

(Excerpt from a conversation of
Forrest Baumgardner with Tom Wier)

FORREST BAUMGARDNER, *Chief Electrician*,
Frank Wheatley Pump & Valve Mfr.
Tulsa, Oklahoma.

"FOREST:— DON'T FORGET FUSETRON FUSES DO MORE THAN PROTECT MOTORS — THEY PROVIDE 10 POINT PROTECTION!"

TOM WIER,
BUSS Fuseman,
covering Tulsa, Okla.

1 Protect against short-circuits.*

2 Protect against needless blows caused by harmless overloads.

3 Protect against needless blows caused by excessive heating — lesser resistance results in much cooler operation.

4 Provide thermal protection — for panels and switches against damage from heating due to poor contact.

5 Protect motors against burnout from overloading.

6 Protect motors against burnout due to single phasing.

7 Give DOUBLE burnout protection to large motors — without extra cost.

8 Make protection of small motors simple and inexpensive.

9 Protect against waste of space and money — permit use of proper size switches and panels.

10 Protect coils, transformers and solenoids against burnout.

* Fusetron Fuses have high interrupting capacity as shown by tests of the Electrical Testing Laboratories of New York.

Here's why FUSETRON Fuses give All Purpose protection...

A fuse link combined with a thermal cutout — the result, a fuse with tremendous time-lag and much less electrical resistance.

They have the same degree of Underwriters Laboratories approval for both motor-running and circuit protection as the most expensive devices made.

Made to same dimensions as ordinary fuses, FUSETRON FUSES fit all standard fuse holders.

Obtainable in all sizes from 1/10 to 600 ampere, both 250 and 600 volt types. Also in plug types for 125 volt circuits.

Their cost is surprisingly low.

FUSETRON is a trade mark of the Bussmann Mfg. Co.

Don't Risk Losses!

One **lost** motor . . .
One **needless** shutdown . . .
One **destroyed** switch or panel
One **burned out** solenoid . . .

May cost you far more than replacing every ordinary fuse with a Fusetron dual-element Fuse.

Bussmann Mfg. Co., University at Jefferson, St. Louis 7, Mo. (Division of McGraw Electric Co.)

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KEY ... YOUR OPERATIONS FOR SAFETY

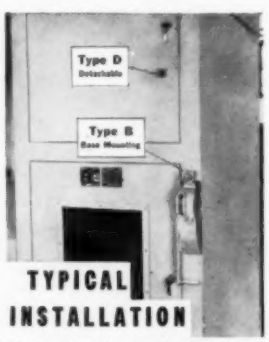
Kirk Key Interlock Systems prevent the authorized person from doing the unauthorized thing! Added safety for your installation and equipment is provided by this device which is applied to two or more movable parts, preventing or allowing movement of one part only when another part is locked in a predetermined position. Unlimited operating schemes can be arranged in electrical installations, processing systems, fluid and pneumatic systems, etc., from combinations as shown, or multiple units of any one of them. Individual locks are mechanical and meet basic mounting requirements. Following are descriptions of the 3 types shown above:

1 **TYPE F**—For flat mounting—Can be mounted on any protective device.

2 **TYPE D**—Detachable....Can be mounted on cell door, gate or compartment. One key retained with door locked open....other key can be retained by operator or used to operate other devices.

3 **TYPE B**—For base mounting—Can be mounted on handle of disconnecting device....Key released when lock is open.

Please write for Bulletin No. 1725 for full description, applications and typical schemes for R&IE Kirk Key Interlocks



TYPICAL INSTALLATION

Shown above is a typical installation of a Kirk Key Interlock System. Fuse compartment can only be opened when interrupter switch is locked open.

R&IE EQUIPMENT DIVISION

I-T-E CIRCUIT BREAKER CO.

GREENSBURG, PA.

The Check List
CONDUCTOR SUPPORT
CLAMPS AND FITTIN
DISCONNECTING SWITCH
INDOOR AND OUTDOO
HORN GAP SWITCH
INTERRUPTER SWITCH
CUTOUTS AND
THERMO-RUPTER
DISTRIBUTIO
EQUIPMENT
SWITCH OPERATI
MECHANISMS
SUBSTATION
OPEN OR ENCLOS
ISOLATED PHAS
HEAVY DUTY BU
KIRK INTERLO
SYSTEMS
AUTOMATIC
SWITCHING
EQUIPMENT
METAL CUBICLE
TESTING DEVIC

SUGGESTIONS FOR SAFETY IN HANDLING CHAINS

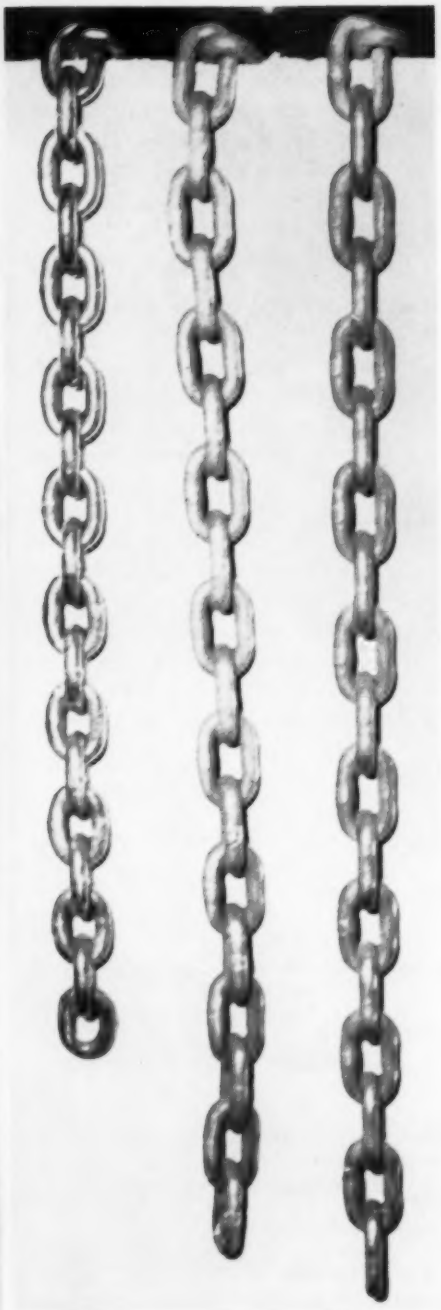


Figure 1 — Stretch in overloaded chain, photographed at the Toledo plant of The National Supply Co. Chain at left is a new one, of normal size. Other two chains were originally of the same size, but were stretched by overloading to the point where any link could break. Regular inspection permits stretched chain and other damaged chain, to be discarded before an accident can take place.

▲ SAFETY in the handling of sling chains is being stressed at the Toledo plant of the National Supply Co., manufacturers and distributors of oil field machinery and equipment. Chains are tested regularly for stretch, cuts and twists, which forecast future breaks. Charts have been distributed throughout the plant showing the safe working loads for the alloy chains used, and giving suggestions for using chains properly.

Here are a few of those suggestions:

"Keep chains free from twists, knots and kinks. Distribute loads evenly on all legs. Lift from center of hooks, never from point.

"Bull-rings and hooks must be stronger than the chains themselves. No failure gives so little indication of overstressing as failure of a bull-ring or hook. These parts are made by our blacksmith, and must be in sturdier sizes than the chain. Because the chain is so much smaller, it must be fastened by connecting links which are larger than the chain."

CAUSES OF CHAIN FAILURE

"The principal cause of chain damage is overloading, by either underestimating the load being handled, or by hooking on to a part improperly.

"The second greatest reason for chain damage is the cutting of the chain metal itself, by wrapping a chain over a sharp edge of a part being lifted. Wood blocking can be used to cushion the chain and prevent it from actually touching the sharp edges.

"Another cause of cut or indented links is due to a whipping action of a casting or other part being turned. This type of work is being done regularly in several departments of our plant and care in this operation can save damage.

"Twists in chain legs may be caused by bent links. More often, twisted links are caused by a chain being stressed with a kinked link."

CHAIN CHECKED FOR DEFECTS

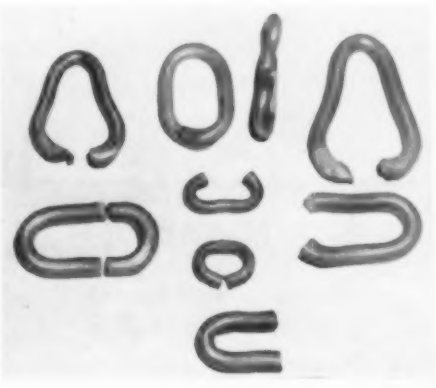
It is the responsibility of chain inspector to detect each of the above defects. The chain is lifted until its full length dangles freely. Inspector checks to see if all hooks hang to the same elevation. Chains must measure the same as the length stencilled on the marking rings. The latter is a small ring attached to the bull-ring on which are stencilled the serial number of the chain and its length.

Visual inspection is considered very important. A glance at the chain hanging instantly tells if the links line up. If they are out of line, there must be a bend or twisted link. The inspector measures the openings of the hooks to determine whether the hook has been strained.

The plant has adopted a program of replacing wrought iron chains with alloy as fast as repairs are needed on the older chains. This project is almost 100 per cent complete with only a few smaller chains still to be changed.

The reasons for this are that alloy steel chains are two-and-one-half times stronger for the same link size. They are harder and less susceptible

Figure 2 — Failures in hooks and links of chain were photographed to emphasize need for care in handling. All of these pieces were damaged through mishandling, either by twisting, kinking, overloading or cutting. Chain inspector endeavors to locate possible failures before accidents can occur.



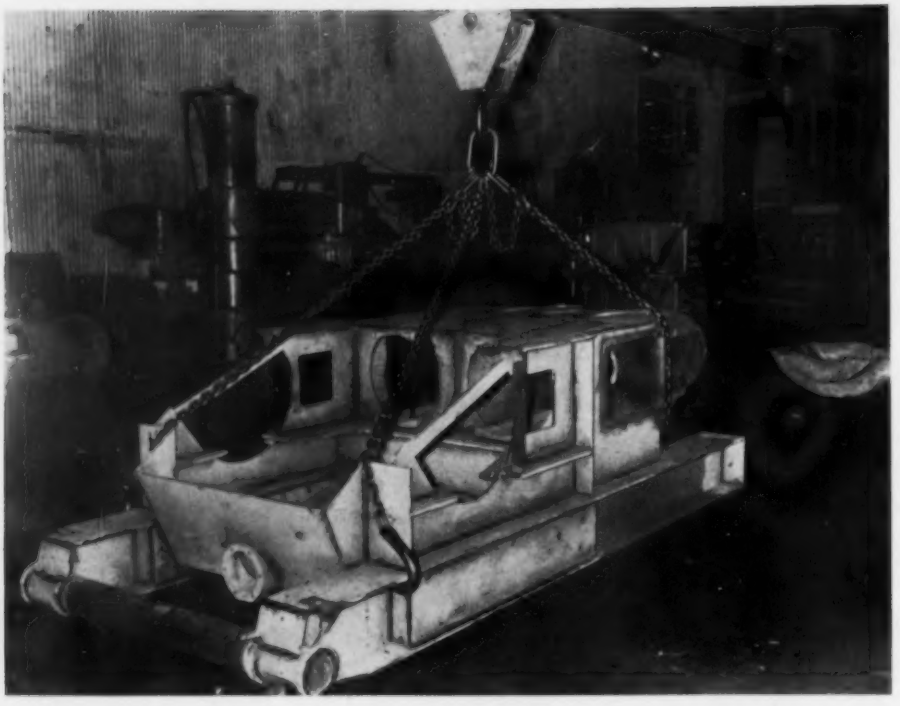


Figure 3 — Heavy loads are lifted easily with sling chains suspended from an overhead crane. Chain must be handled with care, avoiding overloading, cutting and twisting, and should be inspected regularly to avoid accidents.

to cuts or other abrasions. Their design is considered better in that they are flash-welded by machine, with the links so shaped that they do not lend themselves to kinking. They are heat-treated to a given hardness and do not require annealing; in fact, must not be annealed.

CAUTION RULES FOR WORKERS

National Supply's workers are cautioned:

"Each time you use a chain, think for a minute of what is being handled; what the estimated weight is; how the hook-up is to be made; and whether your chain is large enough. If in doubt, consult your chart. Check for twists and make sure no sharp edges are coming in contact with the chain.

"The material we handle is essential and valuable, but it can be replaced. Your life or those of your fellow workers cannot.

"Be careful—save a life."

Here's how you can INCREASE tonnage pickled

Use Heil Steam Jet Agitators For Uniform And Complete Agitation

E-3B For Continuous Pickling

E-3 Type Jet For Continuous Pickling

- **INCREASE TONNAGE PICKLED.** Field reports show increase in tonnage pickled from 20% to 40% due to this uniform and complete agitation.
- **LONG SERVICE LIFE.** Patented Impervious Graphite nozzle construction gives longer service life under most severe operating conditions.
- **HIGH EFFICIENCY.** Standard designs are available to give uniform agitation in all type of of operations Continuous — Batch — Tube — Rod.
- **SAVES ACID.** Violent agitation makes possible the use of lower concentration of acid — thus reducing acid consumption.

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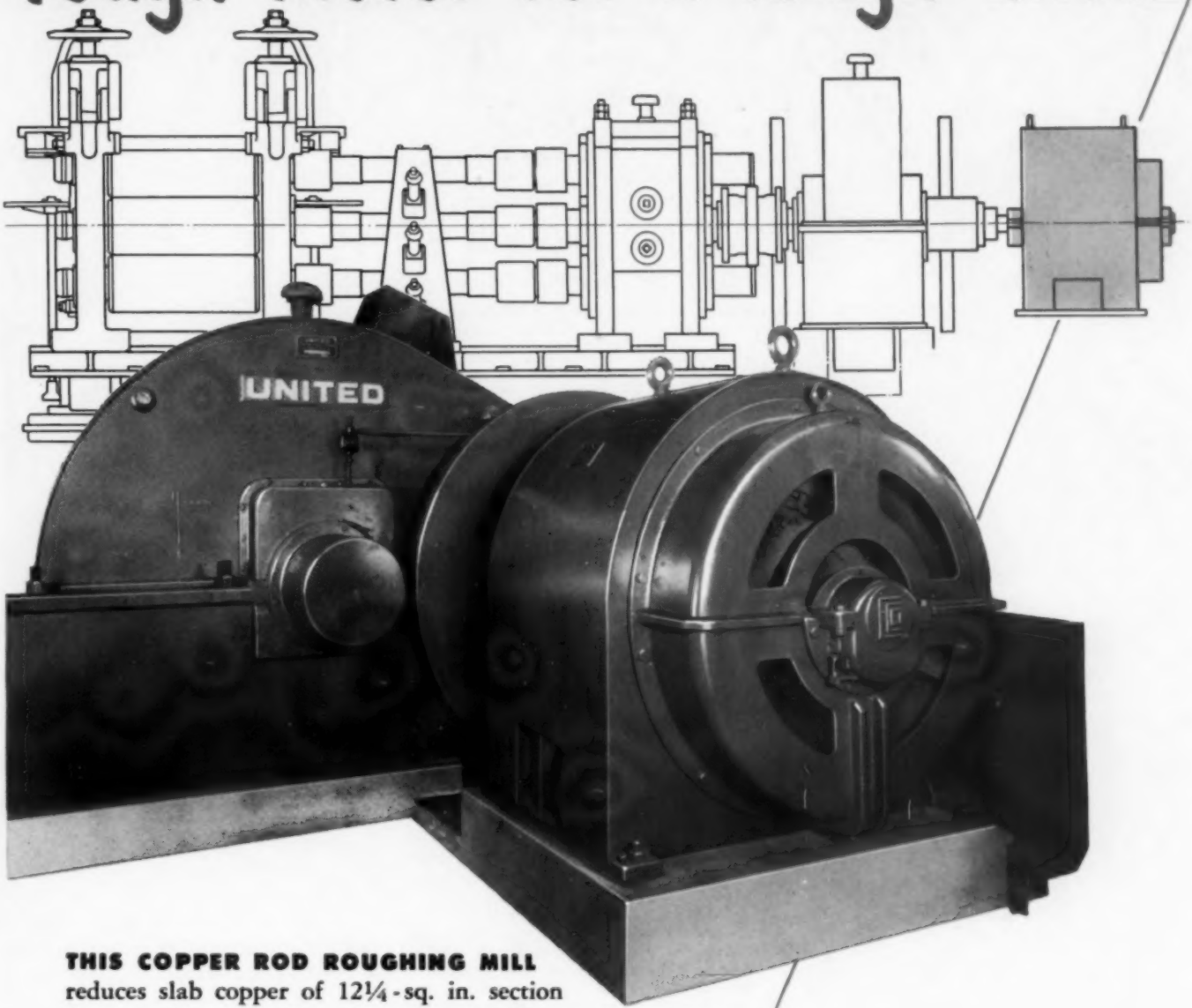
Tough motor for a tough drive



THIS COPPER ROD ROUGHING MILL reduces slab copper of 12¼-sq. in. section down to bars of 1.6-sq. in. section, which certainly ranks as rugged service, demanding a motor that can take shock and heavy current surges. The American Brass Company selected an Elliott motor to drive this new mill, built by the United Engineering & Foundry Company.

The motor is an 800-hp, 710-rpm Fabri-Steel wound-rotor induction motor, with a 300% pull-out torque, driving through gears with a ratio of 6.85:1. Elliott fabricated steel construction provides the rigidity and sturdiness required for this extremely arduous service.

ELLIOTT MOTORS

are widely recognized for their performance in heavy mill drive service. For full details on these motors in their various types, contact your local Elliott engineer, or write Elliott Company, Ridgway, Pa.

Elliott FABRI-STEEL

ELLIOTT Company

RIDGWAY DIVISION

FOR MOTORS 1-200 HP: CROCKER WHEELER DIV. AMPERE, N. J.

R3-19

WIRE ROPE WITH PLASTIC CORE PRODUCED BY J&L

▲ Production of a wire rope with a plastic core — the first product of its kind — was announced recently by Jones & Laughlin Steel Corp., Pittsburgh, Pa.

This unique wire rope was developed to replace fiber core wire rope in the drilling of many oil and gas wells. Other uses for it in the future are anticipated.

Plastic core wire rope is expected to solve many of the problems of the driller who employs the cable tool method. The plastic core in this rope is unaffected by the acids, caustics, and other sub-surface substances which destroy the fiber cores now being used.

Development work on plastic core wire rope was begun in 1946 under supervision of P. B. Somerville, general manager of the J&L Wire Rope Division plant at Muncy, Pa., where the new product is being made.

Besides giving a wire rope that will stand up under adverse drilling conditions, the plastic core will be produced in this country instead of imported, as is the fiber for hemp cores. This would eliminate uncertainty of supply during periods of war or other international stress.

Further, neither lack of moisture during storage nor excessive amounts of moisture during use has any effect on the plastic core. But these conditions have an adverse effect on a fiber core.

The new plastic core may not entirely displace the fiber core in wire rope making for many years. But J&L's production of plastic core wire rope is a start toward use of a more durable material. Drillers will find that the plastic core wire rope eliminates difficulties they have had with fiber cores.

J&L will continue to manufacture the fiber core wire rope they have produced for cable tool drillers. But drillers will find many advantages if they test the new plastic core wire rope.

The following are the advantages of the new rope:

1. The plastic core is not affected by moisture. The hemp in the fiber core, however, needs a small amount of moisture to keep its resilience. Excess moisture promotes growth of fungus in the hemp.

2. The plastic core is not affected by acids, caustics, and other destructive substances which are found in wells in many areas.

3. The plastic core maintains its resiliency. Fiber core's resiliency is maintained by moisture for only limited periods. The fibers break down under shock, and destructive sub-surface substances affect them.

4. The joints in plastic core, produced by a kind of "welding" under heat, are homogeneous, with strength in the splice identical with that throughout the rest of the length. Joints in fiber core, made mechanically, are often weak spots.

5. Plastic core absorbs no water, so the steel of the rope is not subjected to rusting from that source. But fiber core must have a moisture content, or it will disintegrate.

6. Strength and toughness are uniform throughout the length of a plastic core. But fiber core's strength and toughness vary, because hemp is vegetable matter and accordingly is affected by the conditions under which it is grown and harvested.

The J&L wire rope plant at Muncy is prepared to make plastic core wire rope in diameters ranging from $\frac{3}{8}$ to several in. The cores may be surrounded by as few as three and as many as eight steel strands. These strands, in turn, may be made up of seven, 19, 25, or 41 steel wires.

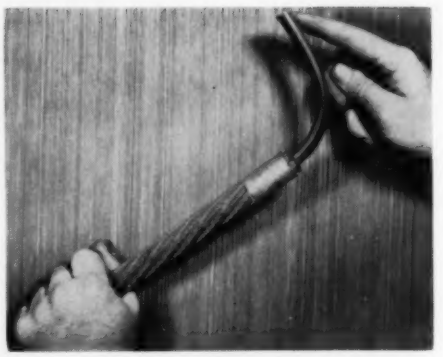
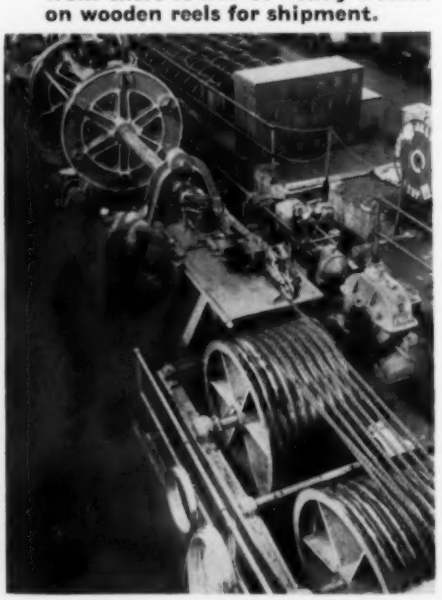


Figure 2 — This is a cut-away sample of the new J & L plastic-core wire rope. The wire strands have been cut away to show the core of plastic, replacing the traditional fiber core. The plastic core is unaffected by acids, caustics and other sub-surface substances in cable tool drilling of oil and gas wells.

Figure 1 — A closing machine at the J & L Wire Rope Division plant at Muncy, Pa. In this machine the separate strands are twisted around a core to make wire rope. The strands are threaded from bobbins through the large wheels in background, then twisted and "closed" under pressure through the die where the operator is standing. The completed rope is passing over the capstan in foreground, and from there it will be neatly wound on wooden reels for shipment.



In electrical installations *where QUALITY counts* use CONDULETS*

Quality does count in practically every electrical conduit installation that you make. When you use CONDULETS you know that you are putting in electrical equipment of the highest quality, because CONDULETS have been doubly tested . . . in the factory and in the field.

Crouse-Hinds quality control assures a long-lasting product and field records prove it by the test that only time can give. Thousands of CONDULET installations are still in tip-top condition after twenty, thirty, or even more than forty years of dependable service.

The illustration at the right shows four of Crouse-Hinds' basic quality features that are common to all CONDULETS. The fifth, Wedge Nut Fasteners, is an exclusive Crouse-Hinds feature that has made Obround CONDULETS preferred by electricians everywhere.

1. **Taper tapping.** Condulet threads are taper tapped to match tapered conduit threading. Makes a rigid joint that will not loosen. This assures permanent ground continuity . . . important for safety.
2. **Integral bushing.** A smooth rounded surface protects wire insulation.
3. **Material.** Feraloy . . . a special alloy that is strong and tough, resists corrosion, and gives sharp, full threads
4. **Finish.** A triple treatment provides long-lasting protection . . . exceeds Federal and U. L. specifications.
5. **Wedge Nut cover fastener.** Clear cover opening . . . no projections. No loose parts . . . Wedge Nuts and screws self-retained. No screw holes to align.

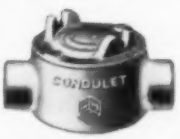
More than 15000 items are listed in the Condulet Catalog including a complete explosion-proof and dust-tight line for use in hazardous locations.

On your next job, use CONDULETS . . . they're made right to last longer.

Type EVA Explosion-Proof Lighting Fixture

Type ARE Arktite Receptacle Equipment

Type FS Condulet With Pilot Lamp Receptacle, Switch and Plug Receptacle



Type GUAC Explosion-Proof Junction Condulet

CONDULET is a coined word registered in the U. S. Patent Office. It designates a product made only by the Crouse-Hinds Company.

Type VC Vaportight Industrial Lighting Fixture

Type FLB Explosion-Proof Circuit Breaker Condulet

Type EPC Explosion-Proof Motor Starter and Circuit Breaker Condulet

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All steel wire used in this and other J&L wire rope is made by J&L, the nation's fourth largest steel producer, at its Aliquippa, Pa., works.

The normal diameters of plastic core wire rope being manufactured for cable tool drilling are: ¾, ⅞, and 1 in. These have six steel strands surrounding a plastic core. The plastic core's diameter is approximately equal to 1/3 the diameter of the finished rope.

Wire rope as long as 40,000 feet can be manufactured by J&L.

The plastic used in the new wire rope is polyvinyl. In manufacture, this plastic is extruded through a cylindrical orifice of a specified diameter, so that close tolerances in diameters can be maintained.

When the wire rope is being formed, the plastic core receives a secondary extrusion under pressure, so that its diameter when received at the wire rope plant is reduced by about 30 per cent.

Thus, plastic with a diameter of about 0.65 in. is reduced to a diameter of ½ in. while becoming the core of a 1-in. wire rope.

SCARFING GANTRY OPERATES 160 HOURS A WEEK

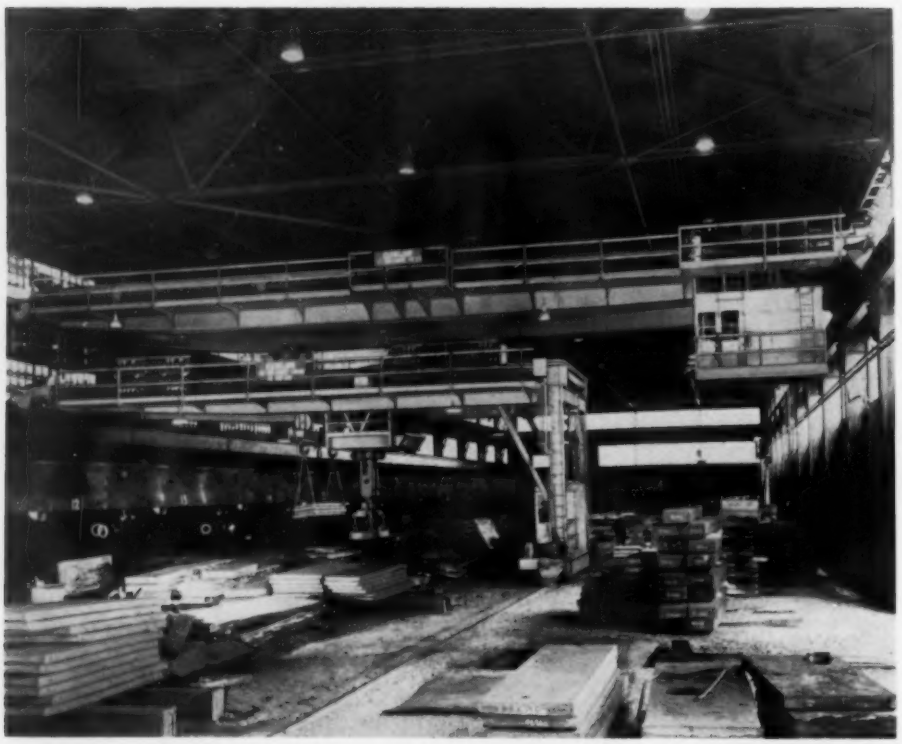


Figure 1 — One Cleveland crane above another. The gantry clears under the overhead crane regardless of position of the hoisting ram.

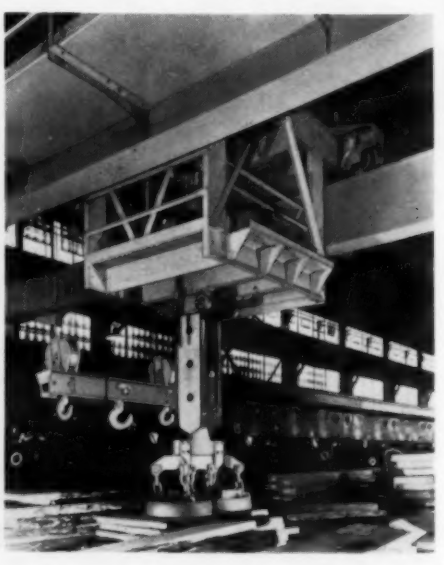
▲A Cleveland single-leg gantry crane with ram-type hoist operates 160 hours a week in the conditioning department of a western Pennsylvania steel company. Equipped with two magnets on the ram and a three-hook spreader beam on an auxiliary hoist, it handles the heavy slabs of steel to various areas in the department, turns them over during scarfing and delivers them to 26 swing grinder booths, each of which is equipped with a Cleveland tramrail crane.

The magnets are used for handling high carbon, chrome nickel and other steel alloys which can be lifted magnetically. Non-magnetic metals, such as titanium and alloys weak magnetically, are handled with chain slings secured to the spreader beam.

The ram hoist has a capacity of 10 tons and the hook hoist is rated 20 tons. The bridge span is 55 ft- 6 in. Distance from top of floor rail to top of wall rail is 17 ft-9 in. No line shafting or other mechanical connection between bridge drives at both ends of crane are employed. Each end truck is individually motor driven. This method of driving the bridge eliminates many bearings and considerable gearing and is an important factor in keeping maintenance at a minimum.

The ram-hoist arrangement is unique in that the hoist machinery is suspended low between the girders. This makes possible the use of a shorter ram and thus reduces the amount of clearance required above the crane. Overhead cranes in the department clear the gantry even with the ram in high position. The height of the gantry was dictated by the hook-lifting work required of the 20-ton hoist.

Figure 2 — By building the hoist into a cage suspended between the girders, considerable headroom was saved. The mast has a heavy rack that is driven by a pinion.



WITH MACK-HEMP *Anniversary Rolls** in the hot strip finishing train

- **M-H Anniversary Rolls ran in the first three finishing train stands during tests, for 8 hours—twice the time normally required between changes.**
- **Time between changes in final 3 finishing stands is increased, because M-H Anniversary Rolls present a better strip to these stands.**
- **M-H engineers point out that correct water application, both volume and pressure, is required for good service from this roll, or any roll.**

We want to call your attention to the remarkable job the new M-H Anniversary Roll is doing by increasing rolling time in strip mills. Our field tests show an increase of 50% and in some cases, more.

M-H's newly developed heat treatment is responsible for the unusual wearing qualities of the Anniversary Roll.

The economics of this roll are readily apparent in less downtime and increased production. We believe you can save money—in six figures annually—with the Anniversary Roll. Let us tell you about it.

**Named in recognition of Mack-Hemp's 150 years of service to the metals industry — 1803 to 1953.*

MACKINTOSH-HEMPHILL COMPANY

Makers of the Rolls with the Striped Red Wabblers

PITTSBURGH and MIDLAND, PA.

MACKINTOSH-HEMPHILL PRODUCTS INCLUDE: rolls . . . steel and special alloy castings . . . completely integrated strip mills . . . heavy duty engine lathes . . . Mackintosh-Hemphill rotary straighteners . . . improved Johnston patented corrugated cinder pots and slag-handling equipment . . . shape straighteners . . . end-thrust bearings . . . shears . . . levellers

You can't beat **Ohio Magnets** for **performance**

Morning . . . noon . . . night—Ohio Magnets lift uniformly larger loads over extended periods because they operate *cooler.*

Take this husky Ohio Bolted Magnet, for instance. Heavy-duty strap-wound copper coils are protected by longer-lasting inorganic insulation carefully sealed with non-remelting or asphaltum compound.

For extra magnet performance, extra magnet value—specify Ohio Magnets. Remember, Ohio Magnets lift larger loads longer—*especially with Ohio Magnet Controllers.*
Send for Bulletin 112.
Offices in principal cities listed in Classified Directory.

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OHIO WELDED MAGNETS. 39 to 65" diameter. Lightweight models in 39 & 45". 6-coil types in 46, 55, 65"; 8-coil in 55 & 65". Weld on top where it can't get dented in. Also capsule coil over 45".
OHIO BOLTED MAGNETS. 12 to 65" diameter. 6-coil types in 39 & 46"; 8-coil in 55 & 65". Strap copper coils over 39". Bolts protected in recessed wells. Also capsule coil over 45".
OHIO BASKET MAGNETS. 55 & 65" 4-coil, & 65" 6-coil. For extra heavy-duty service; hefty ears project beyond magnet diameter, ward off damaging blows. No weight carried by bolts. Also capsule coil over 45".
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CHESTER BLAND
President

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Ohio Also Makes Separation Magnets • Heavy-Duty Electric Hoists • Nail Making Machines • Fractional Horsepower, Shell and Torque Motors • Precision Threaded Parts for Aircraft Engine Manufacturers

WESTINGHOUSE DOUBLES GENERATOR PRODUCTION CAPACITY

▲ Westinghouse has nearly doubled its capacity for the production of generators and large motors with an expansion program now being completed at the Transportation and Generator Division at the East Pittsburgh, Pa. works. This program also provides for future expansion as needed. Present generator production schedules correlate closely with the manufacture of turbines at the Westinghouse Steam Division at South Philadelphia, Pa.

The continuing growth of the electric utility industry has called for increased production of generating apparatus, both in numbers of units and in unit sizes. The trend clearly indicated the need for enlarged production facilities, and the expansion program was launched in 1950.

Figure 2 — This view of the East Pittsburgh works of Westinghouse gives a good indication of the relative size of the new generator assembly and test building.

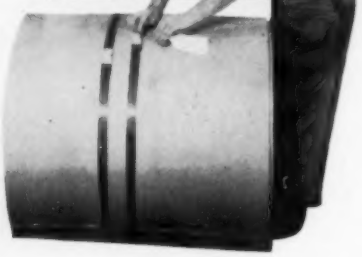
Figure 1 — Taken from above the test floor area of the new assembly and test building, this picture looks toward the opposite end of the structure 1000 ft away. The 25-foot-wide mezzanine can be seen at the right. Along the wall on the left are some of the 25 unit heaters that supply 15,000,000 Btu per hour, and on the upper right wall are some of the 22 exhaust fans, with a capacity of 400,000 cfm. Light from 310 mercury and incandescent fixtures supplies 45 foot candles of illumination.

Heart of the expansion is a new 100,000-square-foot building that parallels the previous manufacturing aisle. Turbine generators up to about 60,000 kw will continue to be built and tested in the former manufacturing areas. Larger machines, and waterwheel generators, will be machined in the former areas, but will be assembled, wound, and tested in the new building.

Coupled to the construction of the new manufacturing building have been numerous changes in the machining and fabricating sections that will feed the assembly areas. Two machining aisles have been rearranged, and new machine tools installed.

An outstanding feature of the new building is its assembly pits for turbine generators. Actually large jigs, the pits will be used for the complete assembly operation. The finished generators will be lifted into the test pits. This procedure will free test pits for their true function, since no generator assembly will take place there.

The test floor apparatus includes a three-phase reactor to be used in running full-load tests on large generators. This new equipment will make it possible to load test more generating



at Washington Steel Corp.

stainless strip

CLEANED WITHOUT SCALE BREAKING

by WHEELABRATOR® MECHANICAL DESCALING

"First cold mill in the country to take 36¾" coils of type 430 straight chrome stainless steel from hot mill to cold mill without scale breaking is attracting attention of most stainless producers. They're watching closely the operation of a shot-blast (Wheelabrator) cleaning unit installed in the strand annealing and pickling line at Washington Steel Corp., Washington, Pa."

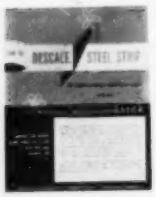
This story which appeared in *Steel* Magazine, points to the impressive savings now possible with Wheelabrator Mechanical Descaling. It quotes Mr. T. S. Fitch, President of Washington Steel as saying, "The new cleaner (Wheelabrator) makes short work of the heavy scale with none of the rolled-in scale, coil digs, slivers, etc. so common to cold-roll methods of scale-breaking. It is faster, more efficient and does a better job quality-wise."

Mechanical descaling of steel strip with the airless Wheelabrator provides these advantages: thorough, uniform cleaning at production line speeds; elimination of scale breaking and reduced use of pickling acid; reduction in manpower, crane service and space requirements; improved quality; and savings in metal since the Wheelabrator removes scale only. Reprints of *Steel* Magazine article available upon request.

WHEELABRATOR ADVANTAGES

- Better quality strip
- More uniform product
- Elimination of scale breaking
- Reduction in manpower
- Reduced use of pickling acid

"HOW TO DESCALE STEEL STRIP AT HIGH SPEEDS AND LOW COST" is the title of a new 4-page bulletin No. 894. Send for a copy today.



American

WHEELABRATOR & EQUIPMENT CORP.

396 S. Byrkit St. Mishawaka, Indiana

equipment and larger units than have ever before been so tested in this country. A new substation supplies the test floor.

A new portable enclosure to be used for balancing and seasoning large rotors will permit all operations to be conducted within a totally enclosed, sound-absorbing structure. The enclosure can be used in any of the three test pits.

A water recirculating system will provide the large quantities of water required for the operation of the test floor. The system utilizes city water for make-up only, and can handle 6,000 gpm.

Figure 3 — An overhead view of a portion of the test area shows (in the center) the enclosure for balancing and seasoning large rotors. In the upper left is the concrete-block structure that houses the three-phase reactors used in full load testing turbine generators.

New, enlarged coil processing facilities extend the advantages of thermalastic insulation to all types of large machines, including waterwheel generators and synchronous condensers. Completed coils enter the assembly area on the mezzanine, from which they are transferred to the winding area on the floor below.

Fabricated parts from the machining aisles enter the new building at three points along its 1000-foot length. Waterwheel generators leave one end of the building, while turbine generators are tested and shipped from the other end.

NEW BLAST FURNACE GAS CLEANING FACILITIES AT DONORA

By S. P. KINNEY

S. P. Kinney Engineers, Inc.

Carnegie, Pa.

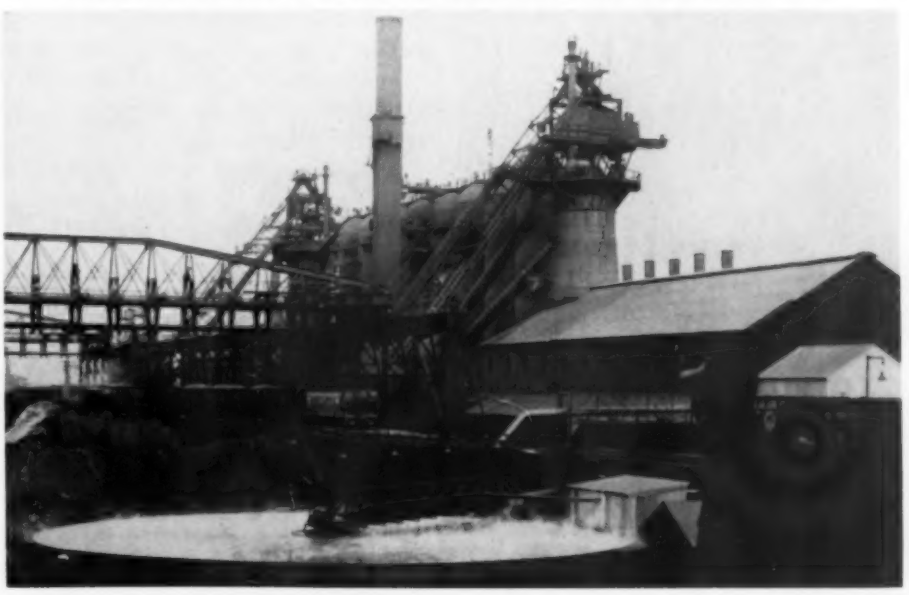
▲ THE blast furnace department of the American Steel and Wire Division of the United States Steel Corp., at Donora, Pa., recently completed a program which eliminates air and stream pollution from its blast furnace operation. This company has pioneered in the use of fine gas cleaning facilities since 1939 and the new system is regarded as the most modern installation of its kind in the country.

GAS WASHERS FOR STOVE GAS

In 1939, a high pressure stationary disintegrator gas washer was installed to clean stove gas for No. 1 blast furnace. This washer had a capacity of 18,000 cfm and was used to clean the gas for one set of stoves having 3¾ x 3¾-in. basket weave checkers. The washer employed low pressure, or stand pipe water, and high pressure water at 150 psi pressure, to clean the gas taken directly from the dust catcher. This gas contained from 3 to 5 gr of dust per cu ft. The gas from this washer was used in the stoves from 1939 until 1952, a period of 13 years. The checkers in the stoves were inspected at various intervals and found to be clean. There was no evidence of any appreciable build-up of dust on the brickwork.

In 1942, a second high pressure stationary disintegrator washer was installed to wash the gas for No. 2 blast

Figure 1 — A new gas cleaning system and a new Dorr thickener were recently installed for the two blast furnaces at the Donora works.

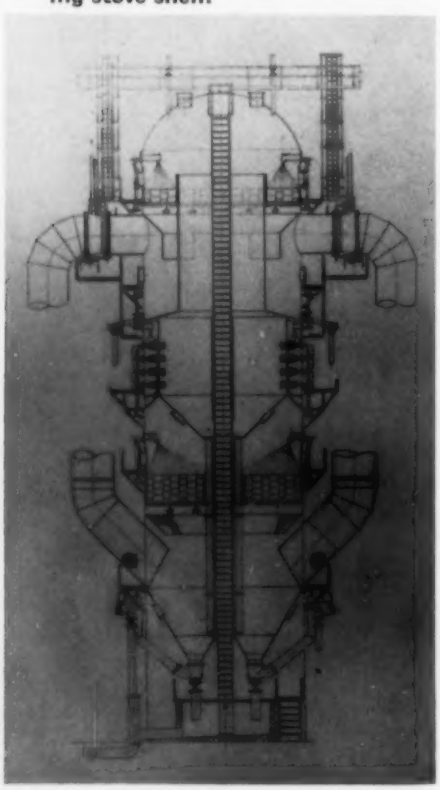


furnace stoves. These stoves were of the radial checker design, and when the washer was installed, making clean gas available, the stoves were equipped with inserts. These inserts reduced the size of the openings, added considerable brick volume, and more than doubled the heating surface available. The washer was designed to clean 30,000 cfm of gas to 0.015 gr per cu ft, using high and low pressure water. Twelve gallons of high pressure and thirty gallons of low pressure water were employed to wash 1000 cfm of gas. The pressure drop was in the order of 23 in. This washer was similar in effectiveness to the gas washer on No. 1 blast furnace.

PREVENTION OF STREAM POLLUTION

The American Steel & Wire Division also took steps in 1939 and again in 1942 to install adequate equipment to prevent stream pollution. In 1939, a 35-ft single tray Dorr thickener was constructed to recover flue dust. Upon completion of the gas washer for No. 2 furnace in 1942, it was necessary to enlarge the thickener to a two tray unit. The waste water from both washers was sent to the enlarged thickener. The sludge was recovered for the sintering plant and the clear discharge water was returned to the river. The water returned had a higher alkalinity than when originally pumped into the water.

Figure 2 — Diagram shows two primary and secondary washers in an existing stove shell.



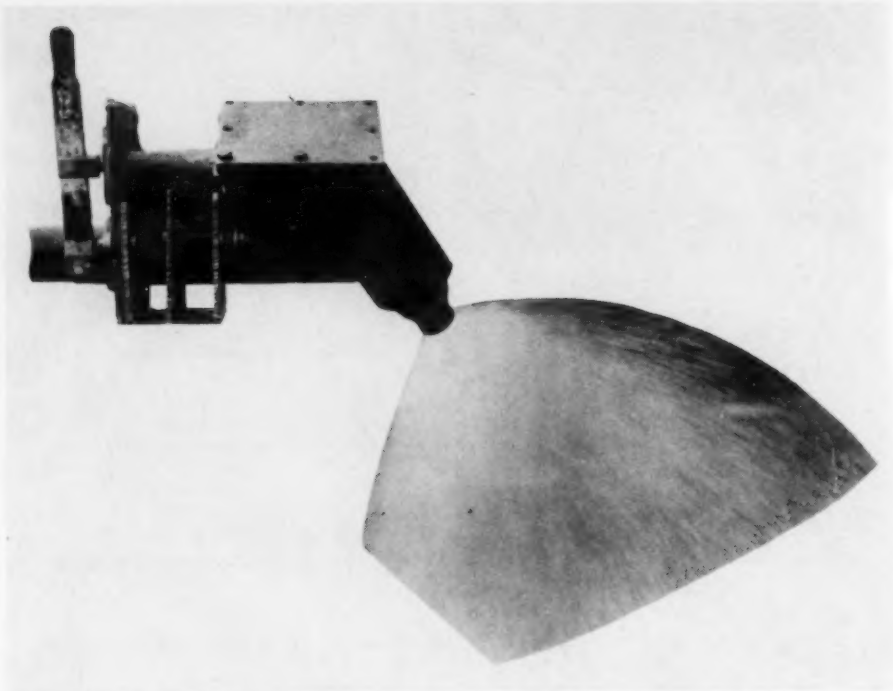


Figure 3 — Self-cleaning spray nozzle shows a solid cone spray pattern.

NEW FACILITIES

To make blast furnace operations compatible with the new atmosphere and stream pollution regulations, it was desired to fine clean all of the blast furnace gas produced by both blast furnaces at Donora. All of the gas used in the stoves and boilers is now fine cleaned. Formerly, clean gas was used only in the stoves and the gas taken directly from the dust catchers was utilized in the boiler burners, along with additional coal fuel. The new facilities include gas washing equipment for all the gas, plus new pumping facilities, a new single tray Dorr thickener, a new filter house, and thirty-two new gas boiler burners, with auxiliary oil burners for each boiler. The new installation was placed into full operation in September, 1952.

The gas cleaning system showing two blast furnaces and the new Dorr thickener is shown in Figure 1.

NEW GAS WASHERS

To handle the gas produced by two blast furnaces, two 75,000-cfm gas washers (Figure 2) were installed in an existing stove shell, 24 ft diam x 110 ft high, which was divided vertically into two halves by bulkheading through the center. A combined primary and secondary Kinney type gas washer was installed into each half of the shell. The gas cleaning system was made flexible so that the gas from both furnaces could be processed by either washer. With this arrangement, ample cleaning capacity is available for all the gas produced by the two blast furnaces, and it will not be necessary to bleed any raw gas direct into the atmosphere.

In the primary and secondary type washer, the gas enters at the bottom of the washer through a 78-in. inside diam main. The gas travels upward through a 4-ft bank of ceramic tile equipped with removable inserts, which gives the gas a primary cleaning. A battery of manually operated self-cleaning spray nozzles (Figure 3) are located directly above this tile bank; these operate at a pressure of 15 psi. The operating mechanism is contained in a heavy cast iron body and the nozzle section is of cast bronze. The sprays give a full solid cone spray with the spray element being arranged so that it may be removed from the nozzle tip for automatic cleaning by means of a simple operating mechanism. Cleaning can be accomplished in a matter of seconds by operation of a lever at the rear of the nozzle outside of the spray chamber. This lever raises the diffuser into the stream of flowing water passing through the feed pipe. When the diffusing element is in this position, the accumulated foreign matter is washed from the element. The unit is then returned to its normal position by moving the lever.

8 cell cooling tower driven by 8 Wagner Multi-speed Motors.

Here's a job for *Rugged* motors

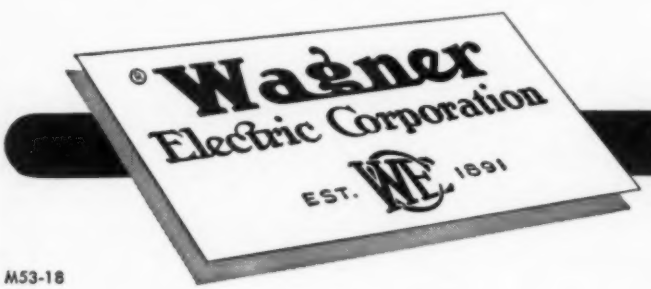
This 8 cell Marley Cooling Tower, at Pueblo, Colorado, provides a steady supply of 6600 gallons of cooling water per minute for a steam power plant. There are 8 fans with blades 22 feet in diameter that are driven, through gear reducers, by 8 Wagner two-speed, totally-enclosed fan-cooled motors. These 440 volt motors are each rated 75/19 hp.

Cooling towers need motors with plenty of stamina. They must operate without attention, day in and day out, completely exposed to all kinds of weather.

Wagner totally-enclosed fan-cooled motors are built to operate under severe conditions. They are available in steel or cast iron frames, in standard or explosion-proof types, single-speed or multi-speed, single phase, 2 phase or 3 phase, in ratings to 250 hp.

For your requirements, there is a Wagner Motor to fit every need—a complete line for all current specifications, with a wide variety of enclosure types and mountings. Bulletin MU-185 gives full information. Do you have a copy?

Your nearby Wagner engineer will be glad to help you select the *right* motors for your next application. Call the nearest of our 32 branch offices, or write us.



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ELECTRIC MOTORS • TRANSFORMERS • INDUSTRIAL BRAKES
AUTOMOTIVE BRAKE SYSTEMS – AIR AND HYDRAULIC

BRANCHES IN 32 PRINCIPAL CITIES

M53-18

From the tile bank, the gas ascends through a set of stationary disintegrators. Each disintegrator consists of an alloy cast iron venturi throat equipped with a high pressure stainless steel spray nozzle at one end and an adjustable stainless steel deflector cap at the other. The nozzle ejects a finely divided spray which has the ability to intimately mix with the gas and wet the particles of dust. This contact is further augmented by the venturi shape of the chamber and the double serrated edges on the deflector cap. Adjustment of the cap and the flow of water determine the desired degree of cleaning. Contact of this mixture on the deflector cap creates a completely disseminated mist and results in an efficient wetting of the solid particles in the gas, thus making the particles heavy enough to drop from the gas stream.

From the disintegrator chamber, the gas continues its upward course to the moisture eliminator section where it makes a 180 degree turn. It then passes through a 2 ft bank of ceramic tile with removable semi-star inserts. Over this tile bank another battery of sprays is located. These operate intermittently to clean any accumulation of dirt from the tile. This ceramic tile bank serves a dual purpose; first, it acts as a collecting surface for any wetted dust particle which has not become heavy enough to fall from the gas stream of its own accord; and second, it is also used to remove droplets of entrained moisture that are still in the gas stream. The gas contains approximately 3 to 4 gr of dust per cu ft at the inlet of the washer and is cleaned to 0.025 gr per cu ft. The gas is now sufficiently clean to be effectively utilized in the hot blast stoves or in the boiler burners. During consummation of this gas, there is no visible discharge to the atmosphere from the stove or boiler stacks.

GAS VALVES

This finely cleaned gas is discharged from the washers via two 72-in. gas mains; one gas main to each washer. Into these gas mains were installed two 72-in. plate type gas valves. Each valve is self-contained and embodies an expansion joint, the retracting mechanism being completely independent of the structure of the valve body. The clamping flange is capable of instant and positive movement in both directions and has sufficient pressure to maintain a tight joint. Gear reduction on the plate drive permits rapid manual operation without undue exertion by the operator.

BOILER BURNERS

The boiler house was equipped with thirty-two boiler burners. These boiler burners were installed in the ash door in the boiler. Coal firing was eliminated and the boiler capacity was materially increased by rearrangement, lowering, and enlargement of the combustion chamber. Auxiliary oil firing equipment was installed by the company. Discontinuance of the use of solid fuel and substitution of clean gas completely eliminated any visible emanation from the stacks of the boilers. Combustion of the gas was controlled so that carbon monoxide in the stack gases was reduced to the very minimum. Each burner was arranged so that the gas enters from the top and finds its way to the nose of the burner through an annular opening outside the air passage. The air is taken from the outside through the center passage of the burner and meets the gas at the nose of the burner.

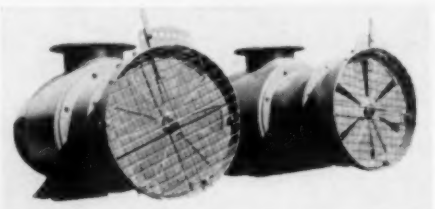


Figure 4 — Two of the thirty-two gas boiler burners equipped with manual louver controls.

Control of combustion is by manual operation of the louver at the air inlet of the burner. The amount of air necessary for combustion with a given quantity of gas is determined by the operator. The louver at the air inlet is equipped with ball bearings and rollers to allow for free movement and is protected by a wire screen.

OTHER EQUIPMENT

Pump house—A pump house, size 104 x 20 ft was constructed to house the pumps and other necessary equipment used to supply water at approximately 4500 gpm for use in the washers. Most of the water used in the gas cleaning comes from the bosh; the rest is make-up water.

Water strainers—This water, taken from the sump, is forced by low pressure pumps through a basket strainer and subsequently through two 6-in. automatic self-cleaning strainers.

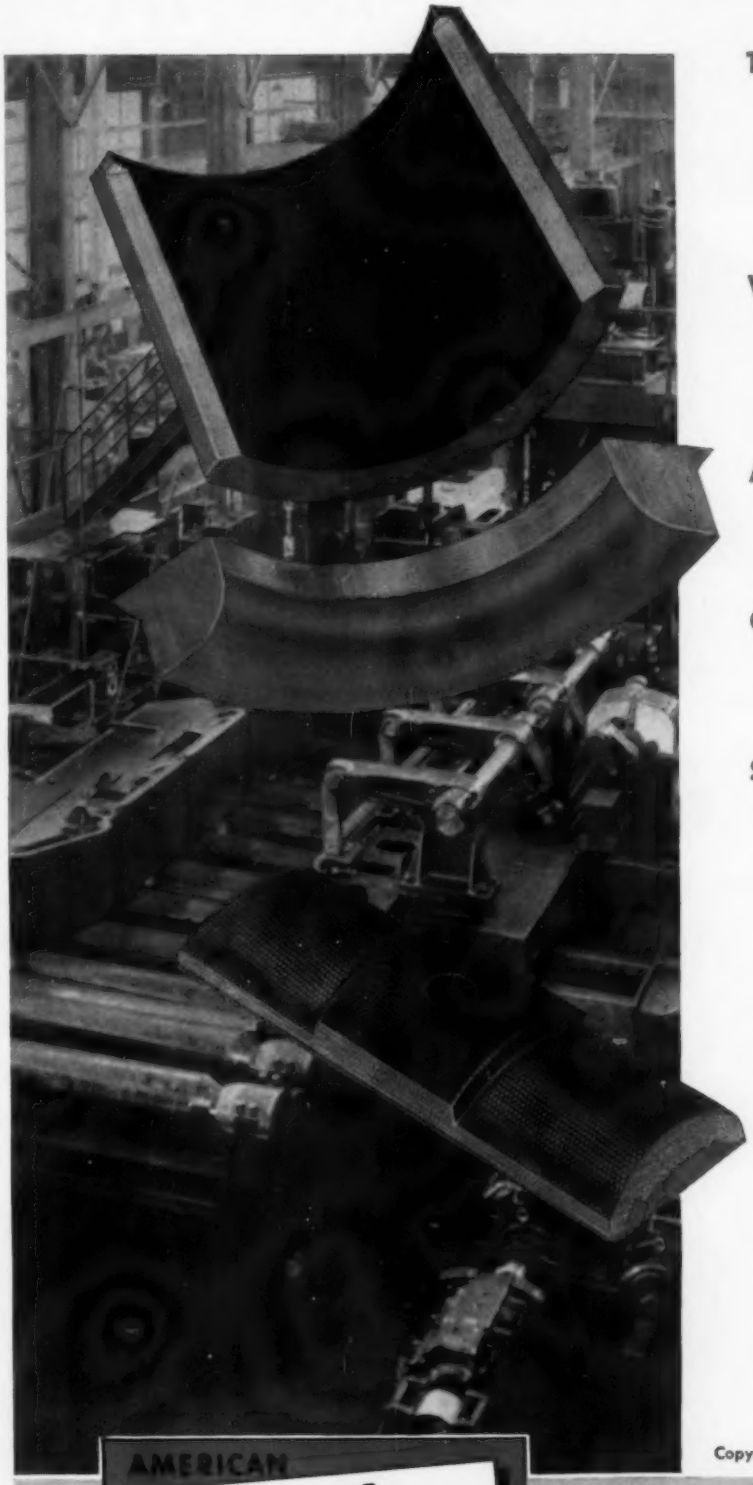
Sludge recovery—The bottom cone of each washer can be flushed by means of a 16-in. quick opening valve. Two 16-in. overflow pipes are also provided to carry away the sludge and water over-flow. Dirt and water from the sump and overflow pipes are carried by a 24-in. pipe line by gravity to the thickener.

The thickener consists of a steel tank shell, 90-ft diam x 9 ft deep, constructed on a concrete bottom. A Dorr thickener, Type "S" was installed in the steel tank. This thickener can handle an average of 6300 gpm of wash water with a maximum of 6800 gal. Two "Type No. 3" Dorrco duplex pressure pumps were furnished. One pump is used to remove the settled sludge which contains from 45 to 50 per cent solids. The second pump is used as a spare. The overflow water returns to the river and the sludge is pumped to the filter house.

The filter house contains a disc type American continuous filter. The filter discs consist of wedge-shaped sectors covered with a cloth filtering material and are assembled around a center shaft. These discs revolve through the sludge in a large tank at the bottom of the filter. The submerged sectors are under a vacuum which forms a cake of solids on each side. As the discs reach the discharge point, the vacuum is released and the low pressure air is forced back through the shaft to the sector in the discharge area and subsequently to the underside of the dust cake. This helps release the cake from the cloth and facilitates discharging. The revolving discs then pass through the scrapers where they are thoroughly cleaned.

Over 9,000,000 gal of water per day is used in the entire process and is returned to the river as clean as when it was removed. The new equipment is three times the size and much more effective than the old facilities. This new equipment minimizes stream pollution and the discharge of any visible dust or smoke particles from the stove or boiler stacks. American Steel and Wire's objective has now been realized with added utilization of the finely cleaned gas and recovery of valuable flue dust for reprocessing.

A-B-K BEARINGS CUT YOUR MAINTENANCE COSTS *per ton rolled!*



They wear longer

A-B-K bearings are dense, homogeneous moldings formulated specifically for the rolling mill industry. Records prove their superior wear in many applications.

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Down time is reduced. Because A-B-K bearings protect heavy roll and spindle parts, maintenance machining costs are cut.

Are light in weight

20 cu. in. of A-B-K weighs only *one* pound. Crane work and multiple handling are eliminated.

Cut lubricant costs

Grease or oil *can* be used. But in many successful A-B-K applications, *water* alone is the lubricant.

Save power

Accurate power consumption records prove startling savings on A-B-K installations . . . up to 30%.

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Our engineers can help cut your maintenance costs with A-B-K bearings. Write us about your applications today.

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LAMINATED FABRIC BEARINGS

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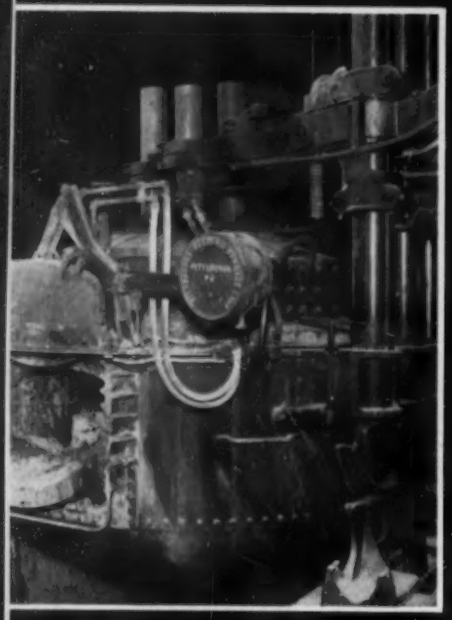
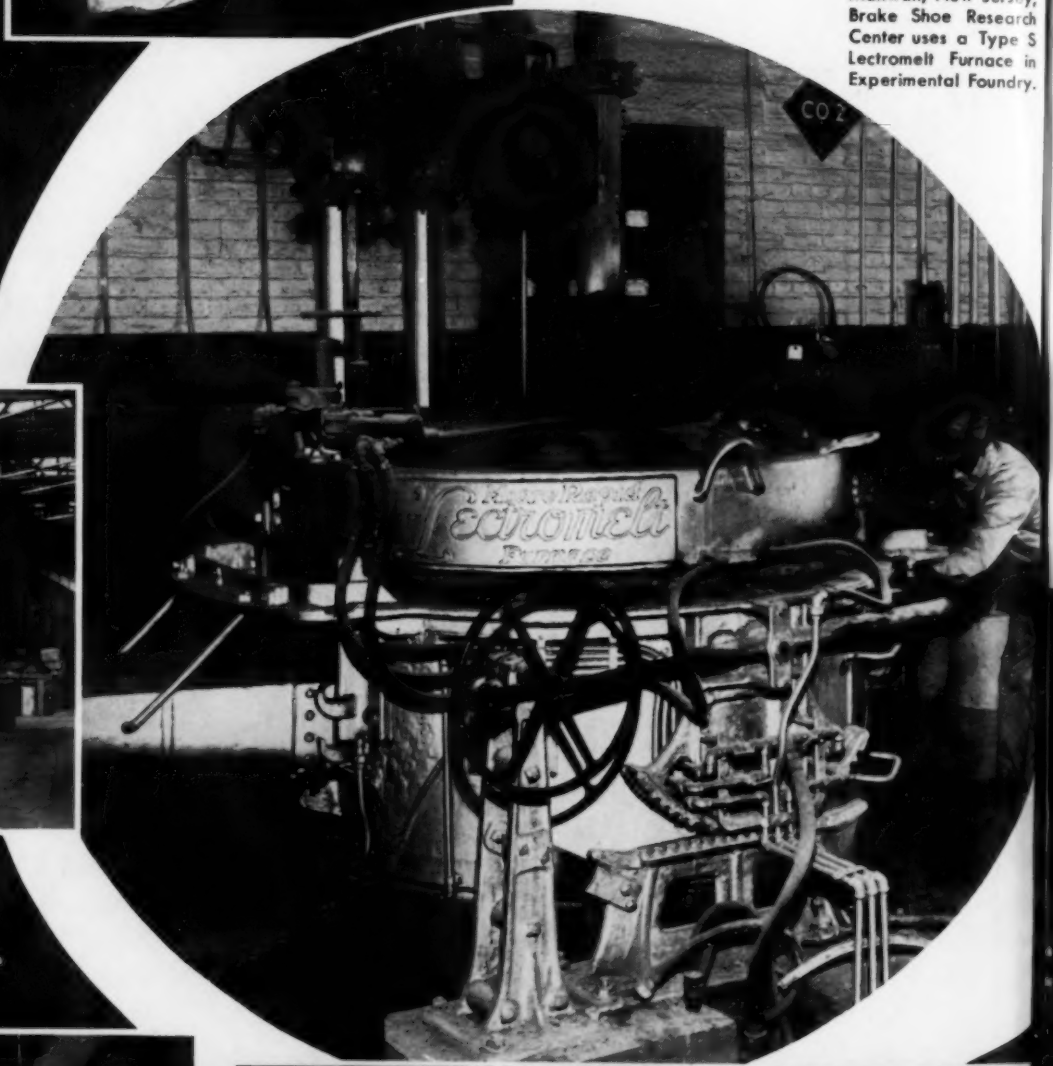
HOWA standardizes

Two OPT Lectromelt Furnaces work constantly at AMSCO Division, Chicago Heights, Illinois.

At New Castle, Delaware, AMSCO Division, a Type Q Lectromelt Furnace.

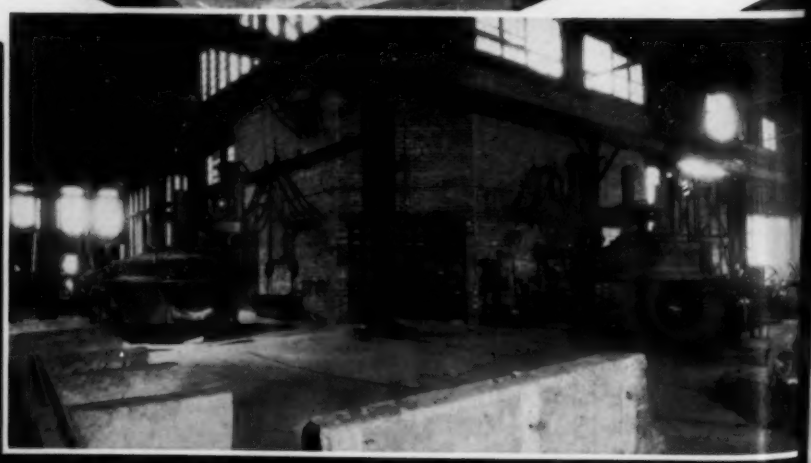


Mahwah, New Jersey, Brake Shoe Research Center uses a Type S Lectromelt Furnace in Experimental Foundry.



Electro-Alloys Division at Elyria, Ohio uses three Lectromelt Furnaces: Types QT, ST and TT.

The AMSCO plant at St. Louis uses two Type Q Lectromelt Furnaces.



There are three Type Q Lectromelt Furnaces in the Denver, Colorado, AMSCO Division.

AMERICAN BRAKE SHOE

...high grade production

Depend on Lectromelt* Furnaces for research and production

American Brake Shoe tests and proves metal formulae and casting procedures in the Experimental Foundry at their Research Center at Mahwah, N. J. A new cupola, in combination with a two-ton Lectromelt Furnace, provides the close control required for research . . . plus the capacity to test accepted new procedures under actual conditions of production.

After establishing efficient methods for new procedures, they're relayed to the company's many divisions. And the high standards set in the Research Center at Mahwah become the production standards at the plants.

Indicative of the confidence American Brake Shoe places in Lectromelt Furnaces is the extensive use of them in various divisions, as indicated on these pages.

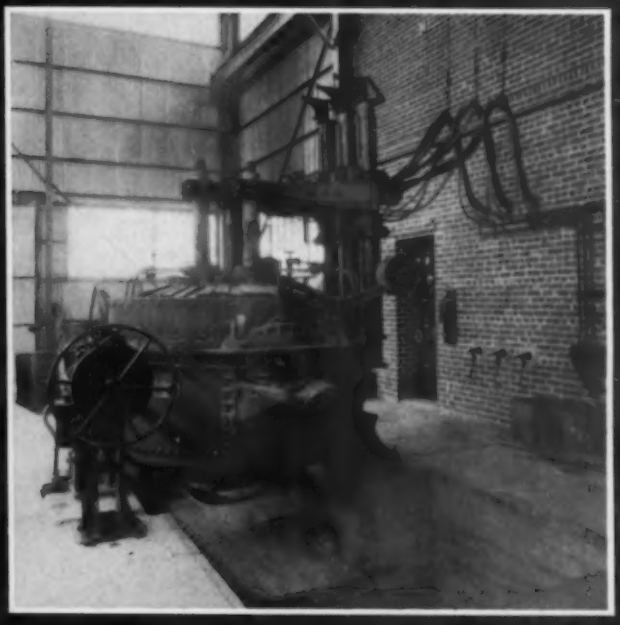
For Catalog No. 8, describing the advantages of Lectromelt Furnaces, write: Pittsburgh Lectromelt Furnace Corporation, 310 32nd Street, Pittsburgh 30, Pennsylvania.

*Reg. U. S. Pat. Off.

Manufactured in . . . CANADA: Lectromelt Furnaces of Canada, Ltd., Toronto 2 . . . ENGLAND: Birlec, Ltd., Birmingham . . . FRANCE: Stein et Roubaix, Paris . . . BELGIUM: S. A. Belge Stein et Roubaix, Bressoux-Liege . . . SPAIN: General Electrica Espanola, Bilbao . . . ITALY: Forni Stein Genoa. JAPAN: Daido Steel Co., Ltd., Nagoya

Even in Canada at Joliette, Quebec, it's Lectromelt, one Type Q and a CQT.

At Los Angeles, the AMSCO Division has three Lectromelt Furnaces: two Type Q's and an S.



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Chemical solvents removed 1650 lb. of deposits from boiler previously "cleaned" by turbining

When you consider that liquid chemical solvents will reach wherever water will flow, you can soon appreciate the many advantages of cleaning with chemistry.

Where mechanical devices, rattling, and turbining fail to clean—in crevices, around angles, through openings—Dowell solvents are designed to dissolve and loosen scale and sludge . . . carry away these profit-stealing deposits quickly and easily.

For example, Dowell recently cleaned a 150,000 pphr boiler that had previously been turbine-cleaned. Although the chemical cleaning required only a few hours, Dowell engineers removed 1,650 *additional* pounds of deposits from the boiler. Best of all, no scaffolding or dismantling of equipment was necessary. Dowell-designed equipment was used to introduce special liquid solvents through regular connections. Downtime was kept to a minimum.

What is *your* cleaning problem? Dowell has extensive experience in cleaning all kinds of process and heat exchange equipment. Dowell furnishes trained personnel, pump trucks, and control equipment.

Dowell engineers apply liquid solvents according to the technique demanded by the job: for example, by filling, spraying, jetting, cascading or vaporizing.

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Date-line Diary...

April 2

▲ The No. 3 open hearth shop at United States Steel Corp.'s Homestead works was closed down for a safety inspection which will determine whether the shop can be restored to operating condition.

▲ In its annual report for 1952, Republic Steel Corp. predicts capacity output for the first three-quarters of 1953.

▲ The Commerce Department reported manufacturers' sales in February totaled $24,100,000,000, or $1,700,000,000 higher than February 1952.

April 3

▲ For the nine months ending March 31, 1953, government deficit amounted to $5,800,000,000, which is approximately what Mr. Truman predicted for this period.

April 6

▲ The Labor and Commerce Department reported that new construction put in place in the first quarter of 1953 rose to $7,000,000,000, or 6 per cent above the same period in 1952.

▲ The AISI reports that the operating rate for the coming week is scheduled at 98.3 per cent of capacity. This is equivalent to 2,216,000 tons compared with 2,190,000 tons one week ago.

April 7

▲ The Aluminum Association reports that production of primary aluminum during February totaled 185,297,920 lb, or 28 per cent higher than February 1952. Shipments of sheet and plate for the month were 107,678,485 lb, or a 39 per cent gain over February 1952 shipments.

April 9

▲ A general pay increase will be sought by the CIO Steelworkers for its 1,125,000 members and they have given notice to the steel industry to this effect.

▲ Belgian Congo copper was reduced 1½¢ a lb to 32¢, and has been made available to United States consumers.

▲ An agreement has been reached between the Bolivian government and the Patino mining interests ending a disagreement which has existed since the tin mines were nationalized in June, 1952.

April 10

▲ American Railway Car Institute announced March deliveries of domestic freight cars totaled 6679, and orders in March totaled 3379 cars. Backlog of cars on order as of April 1 was 68,553.

▲ The Commerce Department reported that business inventories rose to $75,300,000,000 at the end of February, or $1,200,000,000 greater than for the same period one year ago.

▲ At a hearing before the Senate Agriculture Committee, Secretary of Agriculture Benson estimates that farm exports for 1952-53 will drop to $2,900,000,000 from the $4,000,000,000 in 1951-52.

April 12

▲ The F. W. Dodge Corp. announced construction contract awards for the thirty-seven states east of the Rockies in March totaled $1,347,518,000, or 32 per cent above February.

April 13

▲ Based on reports from companies having 93 per cent of capacity for the steel industry, the operating rate is scheduled at 96.7 per cent capacity. This is equivalent to 2,180,000 tons of ingots and castings compared with 2,230,000 tons one week ago.

April 14

▲ An $85,000,000 expansion program is under consideration by National Steel Corp. at its subsidiary Weirton Steel Co., and will probably be started in 1954.

April 15

▲ The United States received increased shipments of iron ore in 1952 from Cuba, Liberia and Venezuela according to the AISI. Total import for the year was approximately 10,900,000 tons.

▲ In a message to Congress, President Eisenhower advocated the sale of 28 U. S. owned rubber plants to private industry.

▲ A six-day strike which had idled 7000 ended when an agreement was reached between United States Steel Corp. and Youngstown & Northern Railroad.

April 16

▲ W. W. Sebald, president of Armco Steel Corp. announced plans to spend $5,000,000 for additions to its Middletown, Ohio plant.

▲ The price of tin declined 1¢ a lb for instant delivery on the United States market, and from 2¢ to 4¢ a lb for future delivery.

April 17

▲ The Navy has cancelled its $154,000,000 contract for J-40 jet engines with Ford Motor Co.

▲ W. W. Sebald, president of Armco Steel Corp. announced the company expects to increase steel prices in the near future.

April 20

▲ Based on reports of companies having 93 per cent capacity for the steel industry, the operating rate is scheduled at 99.3 per cent of capacity. This is equivalent to 2,238,000 tons of ingots and castings compared with 2,228,000 one week ago.

▲ Armco Steel Corp. announced net earnings after taxes for the first quarter of 1953 of $7,767,045, or $1.49 per share on common stock.

▲ According to the Bureau of Labor Statistics factory workers' hourly earnings in mid-March averaged $1.75 an hr, or 1¢ higher than the preceding month. The work week increased 0.3 hrs to 41.2 hrs.

▲ Construction of a new plant at Atlanta, Ga. has been started by the container division of Jones & Laughlin Steel Corp.

April 21

▲ The price of lead was reduced ½¢ to 12¢ a lb in lb in New York.

▲ Automobile manufacturers are turning out autos at a yearly rate of 7,000,000 units, and selling is at a yearly rate of 5,500,000 units.

April 22

▲ The Commerce Department reported inventory increases of business firms was down to $100,000,000 monthly for January and February.

▲ At an annual meeting of the Acme Steel Co. in Chicago, all thirteen directors of the company were reelected. Acme Steel Co. announced sales of $19,586,000 for the first quarter in 1953, or 20 per cent higher than for the same period last year. Net income totaled $1,420,777 or $0.71 a share.

▲ Personal indebtedness at the close of 1952 reached $82,000,000,000 according to the Commerce Department.

April 23

▲ Kaiser Steel Corp. announced that a new monthly record of 130,647 tons of steel ingots was reached in March. Sales for the nine month period ending March 31st totaled $97,581,910 compared with $87,839,884 for the same period one year ago. Unaudited net earnings were $5,592,091, and after payment of preferred dividends is equal to $1.20 per share on common stock.

▲ Ford Motor Co. plans to build an engine plant estimated to cost $60,000,000 next to its engine and foundry plants in Brookpark Village, Cleveland, Ohio.

April 24

▲ Bethlehem Steel Co. is offering $3000 to 45 private colleges, where Bethlehem has been getting men over a period of years, for each graduate who is hired for the Bethlehem Loop Course, and who remains with the company for four months.

▲ Allegheny Ludlum Steel Corp. announced net earnings after taxes for the first quarter of 1953 of $2,098,370, which is equivalent to $1.21 per share of common stock.

April 25

▲ Gwilym A. Price, president of Westinghouse Electric Corp. announced first quarter sales for 1953 were 18 per cent higher than for the same period one year ago.

April 27

▲ Based on reports from companies having 93 per cent capacity for the industry, the operating rate is scheduled to be 100.3 per cent of capacity. This is equivalent to 2,262,000 tons of ingots and castings compared with 2,276,000 tons one week ago.

▲ According to the AISC March bookings of fabricated structural steel totaled 258,482 tons, or an increase of 32,000 tons over March 1952. Shipments during March totaled 266,337 tons, or an increase of 6 per cent over February. Backlog as of March 31 is 2,155,047 tons.

April 28

▲ The Colorado Fuel and Iron Corp. announced net earnings after taxes for the quarter ending March 31st were $2,177,372, which is equal to 81¢ per common share.

▲ Youngstown Sheet & Tube Co. in its report for the first quarter of 1953 announced net income of $6,958,975, which is equivalent to $2.08 per share on common stock.

▲ At its annual stockholders meeting Jones & Laughlin Steel Corp. announced net income of $5,642,000 after taxes, which is equivalent to 85¢ per common share for the quarter ending March 31, 1953.

▲ At a meeting of the 170 member wage policy committee of the CIO Steelworkers, leaders in the union were directed to seek general wage increases under existing agreements.

April 29

▲ In its quarterly report for the period ending March 31st, Crucible Steel Co. of America announced net income after taxes of $2,193,364, which is equivalent to $2.81 per share of common stock.

▲ Inland Steel Co. announced net income for the first quarter in 1953 of $6,805,150, or equal to $1.39 per share on common stock.

▲ United States Steel Corp. and its general operating divisions announced price revisions on numerous items.

▲ United States Steel Corp. reported first quarter sales for 1953 of $928,000,000, which is equivalent to $1.65 per share on common stock. Net income after taxes amounted to $49,375,958.

▲ Pittsburgh Coke & Chemical Co. reported sales for the first quarter of 1953 totaled $13,047,000, or a 13 per cent increase over the same period last year. Net income amounted to $783,000, which is equivalent to 75¢ a share on common stock.

▲ Wheeling Steel Corp. reported a net profit for the first quarter of $3,251,388 or $1.97 a share compared with $1.64 a share one year ago. Total sales were $53,002,824.

April 30

▲ After completing its 10-in. mill, the Seidelhuber Steel Rolling Mill Corp. is now accepting orders for hot-rolled carbon steel bars.

▲ National Steel Corp. reports net earnings after taxes for the quarter ending March 31 of $11,084,933 which is equivalent to $1.50 per share on common stock.

▲ In a report for the quarter ending March 31st, Granite City Steel Co. announced net income of $1,340,146, which is equivalent to 83¢ per share on common stock.

▲ H. H. Tullis, financial vice president of Armco Steel Corp. disclosed that the company expects to be operating at 90 per cent of capacity for the final six months of 1953.

▲ Armco Steel Corp., United States Steel Corp. and Bliss & Laughlin, Inc. increased prices on some types of steel.

▲ General agreement was announced whereby Westinghouse Air Brake Co. will purchase the earth-moving tractor and related business of R. G. Le Tourneau, Inc.

▲ President Eisenhower proposed an $8,500,000,000 cut in the Truman budget for the fiscal year starting July 1.

▲ Department of Commerce reported that manufacture of sales in March totaled $26,700,000,000 up $3,500,000,000 for the same month one year ago. Unfilled orders on March 31 totaled $74,000,000,000 or $5,000,000,000 more than one year ago.

▲ Bethlehem Steel Corp. reported net profits of $30,961,033 after fixed charges equivalent to $3.06 a share compared with $1.80 a share for the first quarter one year ago.

▲ Republic Steel Corp. reported record sales and revenues for the first quarter and net profit of $13,779,049 equivalent to $2.26 a share compared with $1.92 a share for the first quarter of 1952.

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2000 H. P. SLIP RING MOTOR
— PERFECT CONDITION — IMMEDIATE DELIVERY

The motor shown at right is in perfect operating condition, complete with same-as-new controls, including stop and start, reversing, in and out plugging and liquid slip regulator. It's a General Electric, 3 phase, 60 cycle, 2200 V., 236 RPM. Type MT-30-2000-240 Serial No. 5217277. Complete details gladly given on request.

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42″ x 3/16″ UNITED ENGINEERING AND FOUNDRY COMPANY POWER SQUARING SHEAR, Complete with Motor and V-Belt Drive.

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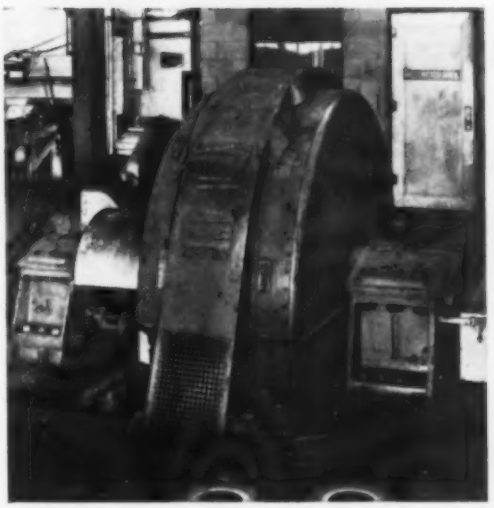
80″ HYDRAULIC STRETCHER LEVELLER, Capacity 80″ wide x 200″ long, complete with all Hydraulic Pumps, Controls, and Motor.

400 H.P. GEAR REDUCTION UNIT (WESTINGHOUSE), Single Reduction, Helical Gears, Ratio 6 to 1.



600 H. P. GEAR REDUCTION UNIT (FARREL-BIRMINGHAM), Ratio 2.95 to 1, Single Reduction, Rebuilt 1950.

CANTON ALLIGATOR SHEAR, Capacity 3″ dia. rounds. 26″ knives. Complete with 35 H.P. A.C. Motor and Controls.

50 H.P. CROCKER-WHEELER D. C. MILL TYPE MOTOR. Size EW, 220 V. 560 RPM.

D & K No. 2 ALLIGATOR SHEAR, 21″ Knives, 7½ H.P. 3/60/220-440 Volt Motor.

5 TON OVERHEAD ELECTRIC CRANE, 47′ Span D.C. Cab Operated.

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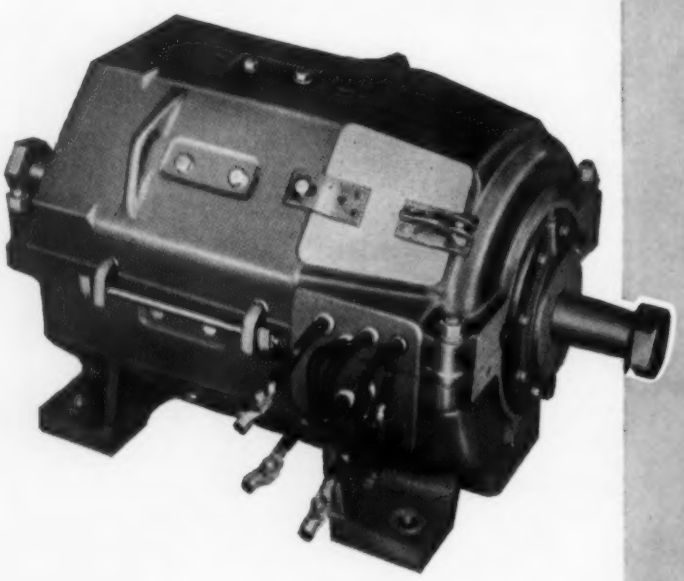

Seven Basic Reasons

WHY THIS MILL MOTOR WILL SET NEW STANDARDS OF PERFORMANCE IN YOUR PLANT

1. BETTER COMMUTATION: Brushes with ample current-carrying capacity—properly designed commutator—specially shaped commutating pole faces.

2. UNIT ASSEMBLY OF FIELD COILS: Formed coil is a solid mass completely insulated and protected from chafing or grounding . . . held firmly in place.

3. HIGHER MAXIMUM SAFE SPEEDS: Anchoring of armature coils with individual wedges permits safe operation at higher speeds—no core bands to come loose and cause trouble.

4. HEAVIER AXLE STEEL SHAFT: Larger in diameter between the bearings, on horsepower basis—made possible by mounting punchings directly on the shaft which is removable.

5. RIGIDLY MOUNTED COMMUTATOR: Bridge construction supports each end of commutator on shaft—no overhang.

6. CAST-STEEL FAN: One piece. Gives big fan performance, yet is no larger in diameter than core for easy armature removal.

7. LOW-INERTIA ARMATURE: Allows motor to start, stop and reverse with minimum stored energy.

Look—
No Core Bands!

Wedges give you the toughest mill motor built

Wedges, instead of bands, hold the armature coils firmly in place on the new Westinghouse Series 600 Mill Motor. This means a stronger armature that is capable of safe operation at higher speeds . . . increased motor efficiency.

Broken core bands are destructive, also core bands can cause damage to the insulation on armature coils during assembly. Wedges eliminate this risk—make winding a simple operation. Each slot has its own individual wedge . . . made of Class B material. Simplifies servicing and repair work.

Further, complete insulation of the armature provides maximum electrical strength. Mica wrapper and glass tape protect the conductor. Complete armature assembly is impregnated with thermoset varnish. All this adds up to a rugged armature for a strong motor—built to handle your toughest jobs.

There are many more advantages offered by this mill motor that you will want to consider. Your Westinghouse representative has all the facts. Ask him for your copy of Booklet B-4730. Or write direct to Westinghouse Electric Corporation, P. O. Box 868, Pittsburgh 30, Pennsylvania. J-21663-A

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where

MISALIGNMENT

can't be helped . . .

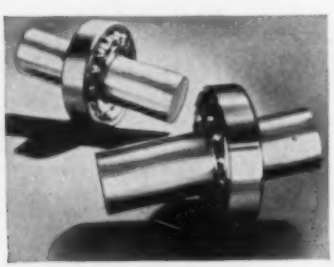
you'll find

SKF

Spherical

Roller Bearings

See how the raceway of the outer ring of this SKF Spherical Roller Bearing forms a section of a sphere. This principle of design of the SKF self-aligning bearings compensates for misalignment due to shaft deflection under load, distortion of the foundation, or other causes.



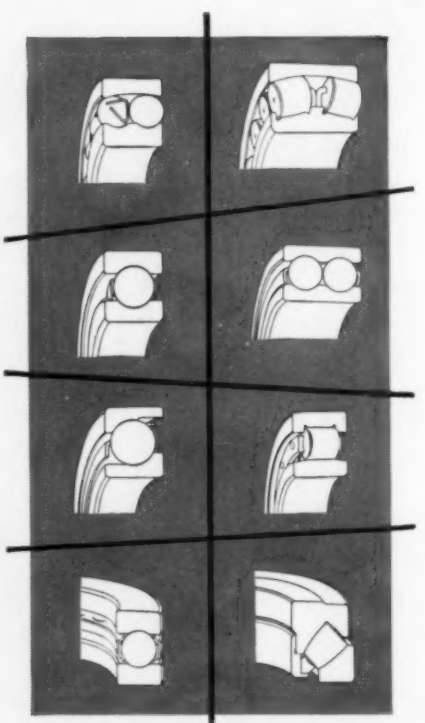
This illustration shows how the principle is also applied to ball bearings, enabling SKF Bearings to operate satisfactorily at high speeds even when some shaft misalignment exists. (The misalignment is exaggerated for clarity.)

Suitable for very heavy radial and thrust loads, SKF Spherical Roller Bearings, like all SKF Bearings, are held well within established tolerance limits, carefully cleaned, protected from rust, and available with cylindrical and taper bores and adapter mountings.

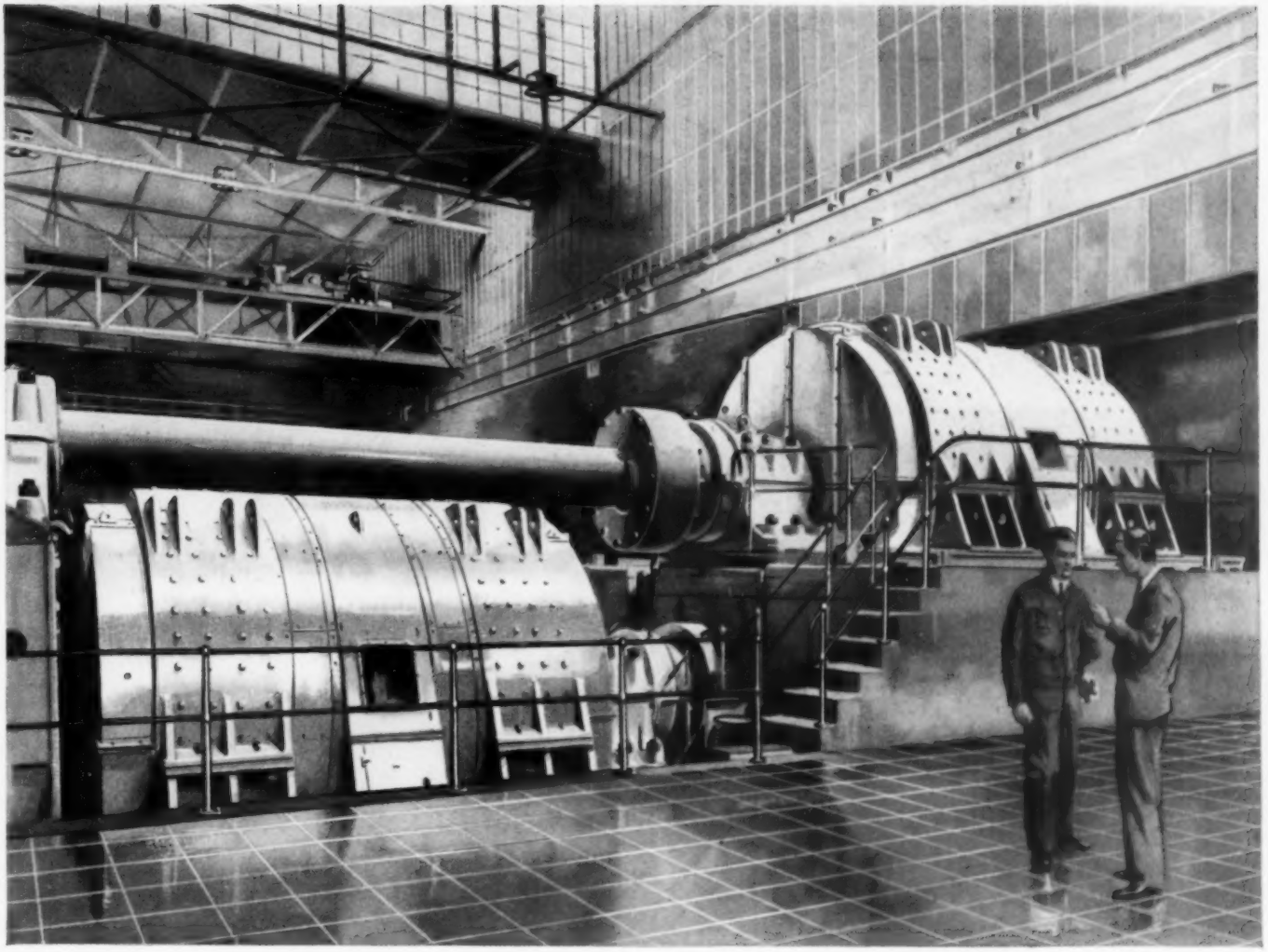
SKF bearings are serving virtually all industry. SKF's unmatched Field and Home Office engineering service helps product designers *put the right bearing in the right place.* **SKF INDUSTRIES, INC.,** PHILADELPHIA 32, PA.—*manufacturers of* **SKF** *and* HESS-BRIGHT *bearings.* 7403

SKF®

BALL AND ROLLER BEARINGS



SKF'S COMPLETE LINE OF ANTI-FRICTION BEARINGS, PLUS **SKF** ENGINEERING CO-OPERATION, HELPS YOU *PUT THE RIGHT BEARING IN THE RIGHT PLACE.*



Modern rolling mill practice . . .

The twin drive, with each roll driven separately, thereby eliminating the pinion stand, was pioneered by 'ENGLISH ELECTRIC' as early as 1922. Shown here are the main motors of a double armature twin reversing drive developing 27,600 peak horsepower, for a 45 inch slabbing mill. The rapid acceleration and deceleration required is obtained by the 'ENGLISH ELECTRIC' standard reversing mill Control System, employing the 'ENGLISH ELECTRIC' Magnavolt rapid response control exciter.

The Company has supplied many drives for both hot and cold rolling mills, including over fifty main drives for hot reversing mills, as well as many other hot mill drives for continuous and semi-continuous strip, sheet, wire rod and merchant sections. Also, the long experience of 'ENGLISH ELECTRIC' in this field provides a wealth of information on all electrical problems . . . power and substations, cabling and ventilating and complete layouts.

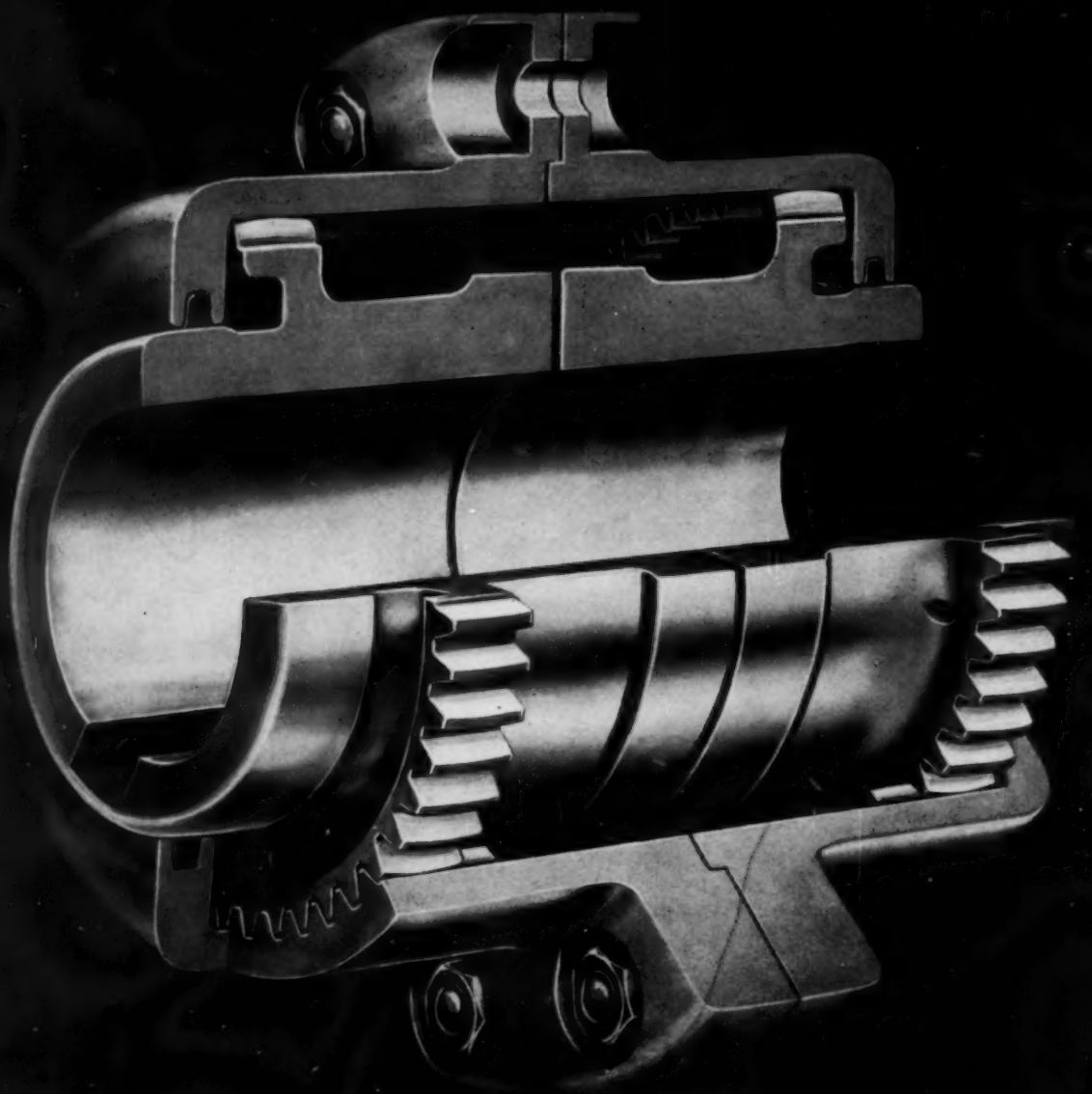
'ENGLISH ELECTRIC'

rolling mill drives

Offices in Halifax, Montreal, Ottawa, Toronto, Winnipeg, Calgary, Edmonton, Vancouver
English Electric Company of Canada Limited. Head Office and Factory: St. Catharines, Ontario

E CANADA

POOLE

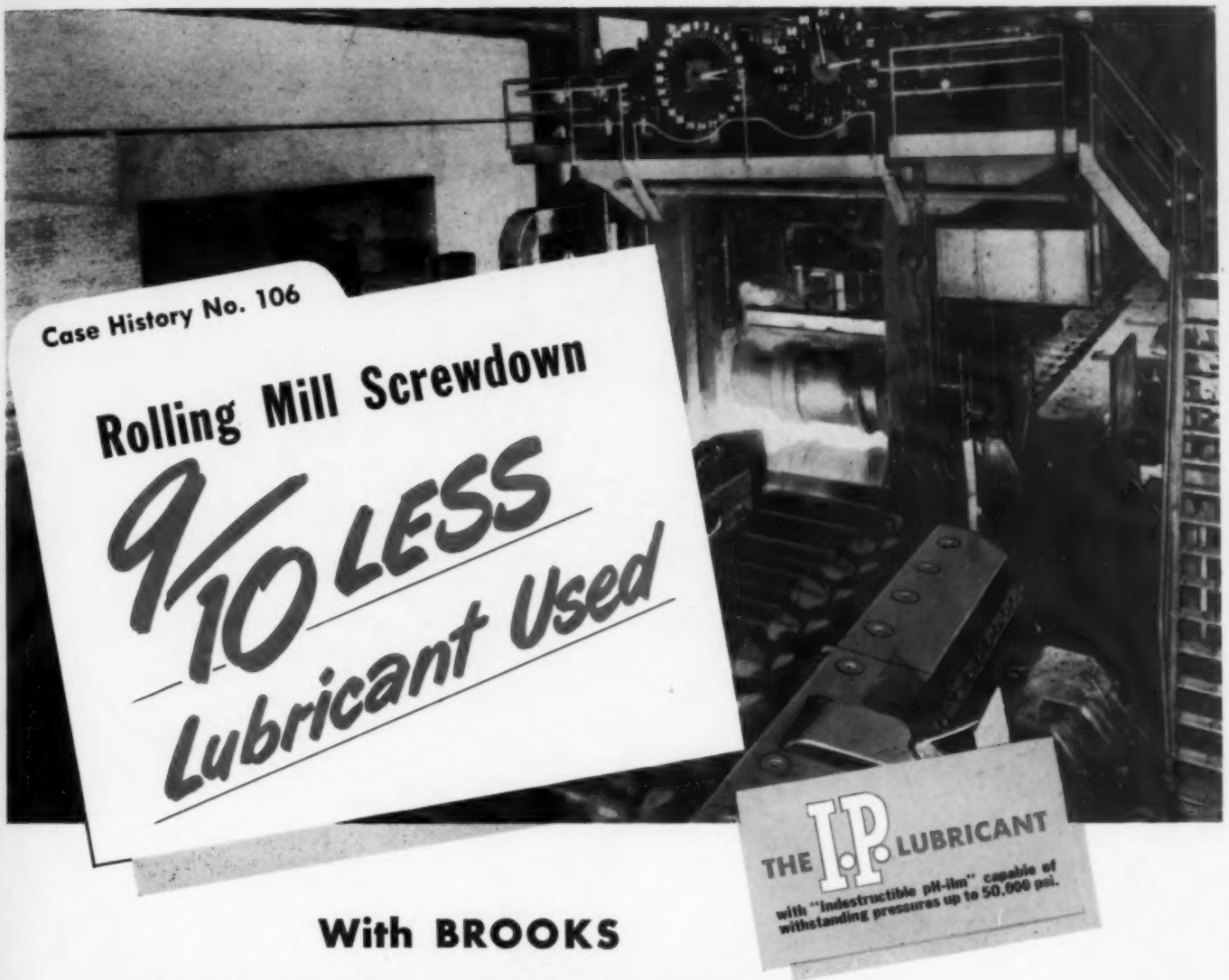


A COPY OF CATALOG GIVING FULL DESCRIPTION AND ENGINEERING DATA SENT UPON REQUEST.

FLEXIBLE COUPLINGS

POOLE FOUNDRY & MACHINE COMPANY

WOODBERRY, BALTIMORE, MD.


Case History No. 106
Rolling Mill Screwdown
9/10 LESS
Lubricant Used
THE I.P. LUBRICANT
with "Indestructible pH-ilm" capable of withstanding pressures up to 50,000 psi.

With BROOKS

LEADOLENE

On each eight hour shift in a large eastern steel plant 30 gallons of good quality steam cylinder oil were used on each of the two screws of a modern slabbing mill. Then LEADOLENE was thoroughly tested, and the tabulated results showed that only 3 gallons per eight hour shift were used on each screw . . . a savings of 9/10 on lubricant consumption. In addition, operating temperature of the screws was reduced from 210° F to 140° F.

On rolling mill screwdowns, the most difficult of all screws to lubricate, LEADOLENE consistently has reduced lubrication consumption and extended equipment service life. With its "Indestructible pH-ilm," plus high adhesiveness, exceptional temperature characteristics, and low pour point and viscosity, LEADOLENE gives superior service on all types of screws used to move apparatus . . . whether open or enclosed, horizontal, vertical, inclined, high or low speed.

Write for technical data or generous samples for your testing.

With LEADOLENE You Get These Characteristics Essential to Good Screwdown Lubrication

pH-ilm Strength . . . 50,000 psi minimum.

Adhesiveness . . . Affinity for metal develops maximum adhesion and reduces dripping and creeping.

Water Repellence . . . Effectiveness is not reduced by water.

Corrosion Prevention . . . Never acidic and will not etch or corrode.

Compounded Stability . . . Will not bleed or change physical condition within a greater temperature range.

Low Temperature Factors . . . Does not harden, crack or decrease in adhesion.

Abrasive Resistance . . . Repellent to adhesion of scale, metallics and other contamination.

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no, this is a "Charging Buggy"

This Morgan buggy places billets or slabs in the furnace singly or in multiples so that both ends are equidistant from the furnace walls. The fitting of a telescopic ram to the buggy makes possible the charging of billets and slabs of different lengths. The quick and precise operation of this charging mechanism makes possible an uninterrupted flow of billets or slabs through the heating furnace with resultant uniform temperatures throughout the entire length of the billets or slabs.

Your problem may be different. If it relates to equipment we build, why not talk it over with our engineers?

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ROLLING MILLS • MORGOIL BEARINGS • WIRE DRAWING MACHINES
REGENERATIVE FURNACE CONTROLS • EJECTORS • GAS PRODUCERS

RM-45

Industry News...

BLAW-KNOX CO. FURNISHES AND INSTALLS PIPING FOR YOUNGSTOWN PLANT OF U. S. STEEL

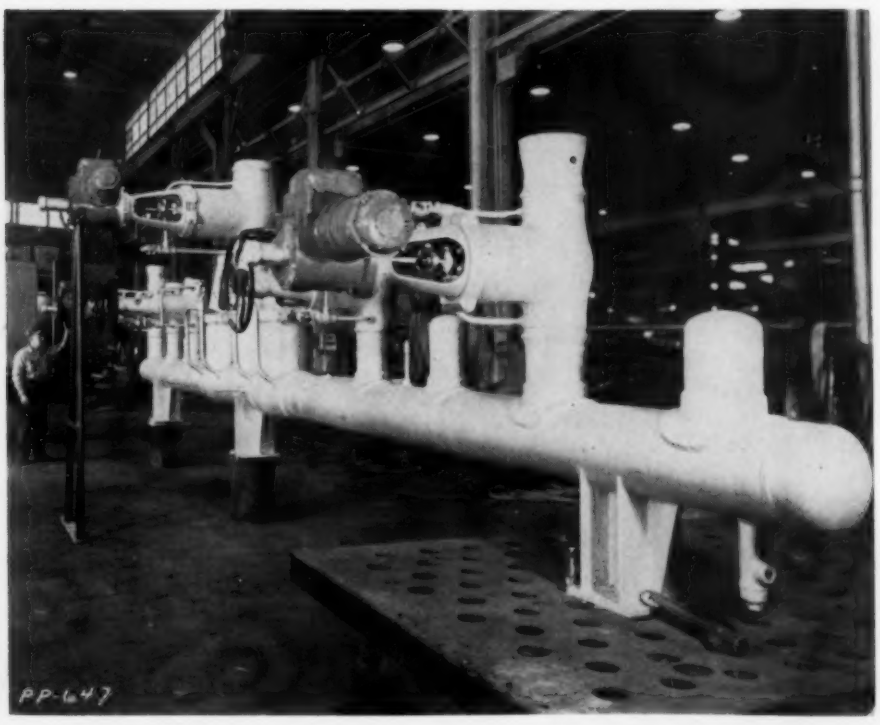
▲ Blaw-Knox Co.'s Power Piping and Sprinkler division is furnishing the complete piping for an addition to the power facilities at the Ohio works of the U. S. Steel Corp. in Youngstown, Ohio. Besides supplying and erecting the piping, Blaw-Knox is erecting an 18,750 kva turbo-generator and all the turbo-generator auxiliaries. The system is designed to handle steam at 900 F and 950 psi.

This steam header, which has a total overall length of 36½ ft and a weight of 10½ tons, is the largest ever built by the Power Piping and Sprinkler Division.

The header is the distribution point for the steam. Two boilers, equipped with automatic controls, feed into the header which sends steam at the high pressure to the generators and to a reducing station which sends steam at reduced pressure and temperature (600 F and 280 psi) to the boiler auxiliaries and existing 280 lb plant steam system. The piping to the turbo-generator is 14 in. in diam and has a thickness of 0.937 in.

The steam header was fabricated in the shops of the Power Piping and Sprinkler division. Shop fabrication gives closer control over the product than is possible in field fabrication.

This steam header, to be installed at U. S. Steel's Youngstown plant, has two automatically controlled boilers which act as feeders for the steam. The header reduces the pressure and temperature of the steam before sending it through the plant.



START MIDDLETOWN BLAST FURNACE

▲ Armco Steel Corp.'s new $40 million blast furnace and coke plant was officially placed in service April 14. Christened the "Middletown Furnace" by W. W. Sebald, Armco president, the new furnace is the first to be built in southwestern Ohio in more than a quarter century. One of the largest and most modern in the world, it will produce about 1300 tons of pig iron a day — almost a ton a minute.

The first charge was sent into the furnace by the three Armco employees with longest service in the Middletown Division's blast furnace, open hearth, and processing departments. Men from Armco's other blast furnaces at Hamilton, Ohio, Ashland, Ky., and Houston, Tex., sent bags of raw materials as good luck tokens to be included in the first charge.

In dedicating the furnace and coke plant, Mr. Sebald announced that Armco will spend an additional $5 million in the coming months for smaller additions to the Middletown plant. These were made necessary by the additional tonnage the plant will now produce, he said.

"Within the next few weeks we'll be getting underway to round out our processing facilities by adding new annealing capacity, enlarging buildings, rebuilding soaking pits, and other improvements," Sebald revealed.

He pointed out that none of this expansion was due to defense demands, but to the great increase in steel consumption in the central part of the U. S.

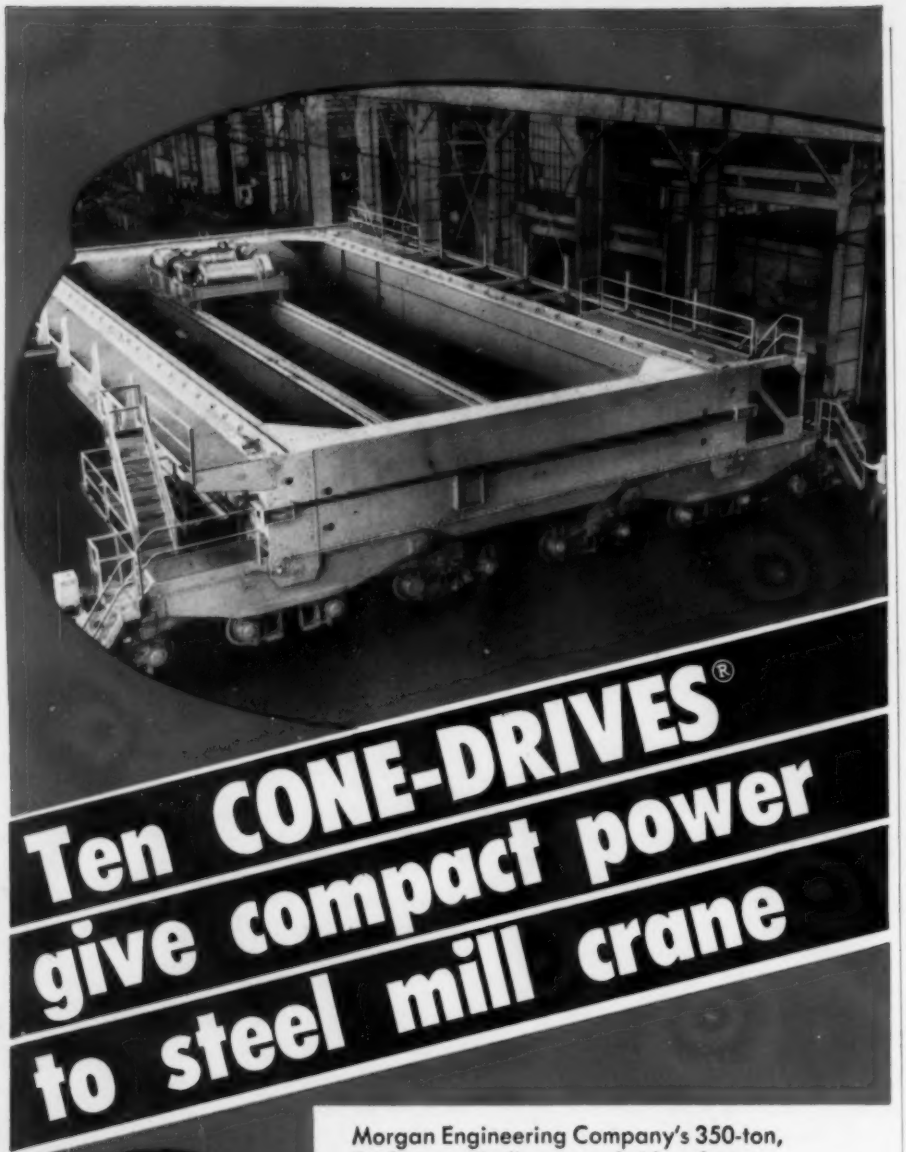
"All this was planned and approved before the first shot was fired in Korea," he stated.

Sebald said that Armco's Middletown plant is now so well balanced that any future expansion would substantially mean an entirely new plant. He called visitors' attention to the fact that the new addition had been laid out so that three more blast furnaces, thirteen more open hearth furnaces, another battery of coke ovens, and complete new rolling mills could be built at the site.

"Although we have no immediate plans for such large expansion," he said, "the land is here, the rough plans are made, and someday we hope to see further expansion start."

COAL WASHERY RAISES COKE PRODUCTION

▲ A new coal washery installed by Colorado Fuel and Iron Corp. at its Pueblo, Colo., coke plant has raised coke production by 16 per cent. Capable of washing a large volume of raw coal a month, the giant vibrating screens and filters remove all rock and slate leaving only the clean coal needed to make high-quality coke.



Ten CONE-DRIVES® give compact power to steel mill crane

Morgan Engineering Company's 350-ton, 76-ft.-span ladle crane bridge features six individual 65-hp. motor drives that avoid line shaft designs.

Key to the success of this design incorporating parallel drives is the 12-in. center distance, 12/1 Cone-Drive gearset in each drive that cuts space requirements, resists shock loads and provides ample safety factor for smooth, rugged, long life operation.

Cone-Drive gearsets are also included in the drives for the 200-hp. main trolley hoists and auxiliary 20-ton and 60-ton hoists.

This is another example of the trend to Cone-Drive gearsets and standard speed reducers in steel mill equipment. Designers and users alike benefit from their long life and high capacity in less space at lower cost.

ALL TEETH IN CONTACT 45°

Standard double-enveloping Cone-Drive gearsets and reducers have greater contact per tooth, more teeth in contact, increased load capacity, greater shock load capacity, longer life, lighter weight—and lower overall cost.

Ask for "Cone-Drive Gears at Work in Industry" (Bulletin No. CD-173) for case histories.

CONE-DRIVE GEARS
A Division Michigan Tool Company
DOUBLE ENVELOPING GEAR SETS & SPEED REDUCERS
7171 E. McNichols Road • Detroit 12, Michigan

The new washing system was installed over a six-month period without a single day's shutdown of operations. With the increased supply of washed coal now available, the coke ovens can turn out 3350 tons of coke a day to feed the blast furnaces of Colorado Fuel and Iron's fully integrated steel mills at Pueblo as well as coke for outside sale.

Colorado Fuel and Iron supplies its Pueblo plant with slack coal from mines in Colorado, New Mexico, and Arkansas. The new washery processes up to 3400 tons of this coal in an eight-hour shift, removing all waste materials with a loss of less than one per cent of the coal itself.

Coal entering the washery is classified according to coking characteristics, ash, and other qualities, and is placed in one of five mixing bins. Then it is dropped through gates at the bottom of each bin, mixed in the proper proportions, and put into a washing jig. Here the coal passes over a screen while an alternating flow of water washes away rock, slate, bone and other refuse.

The washed coal is run over a dewatering screen, dried in centrifugal driers, and conveyed to storage bins for charging.

The fine coal carried away by the water is recovered in settling cones, dried on vibrating screens and other equipment, and is added to the coarser washed coal leaving the driers.

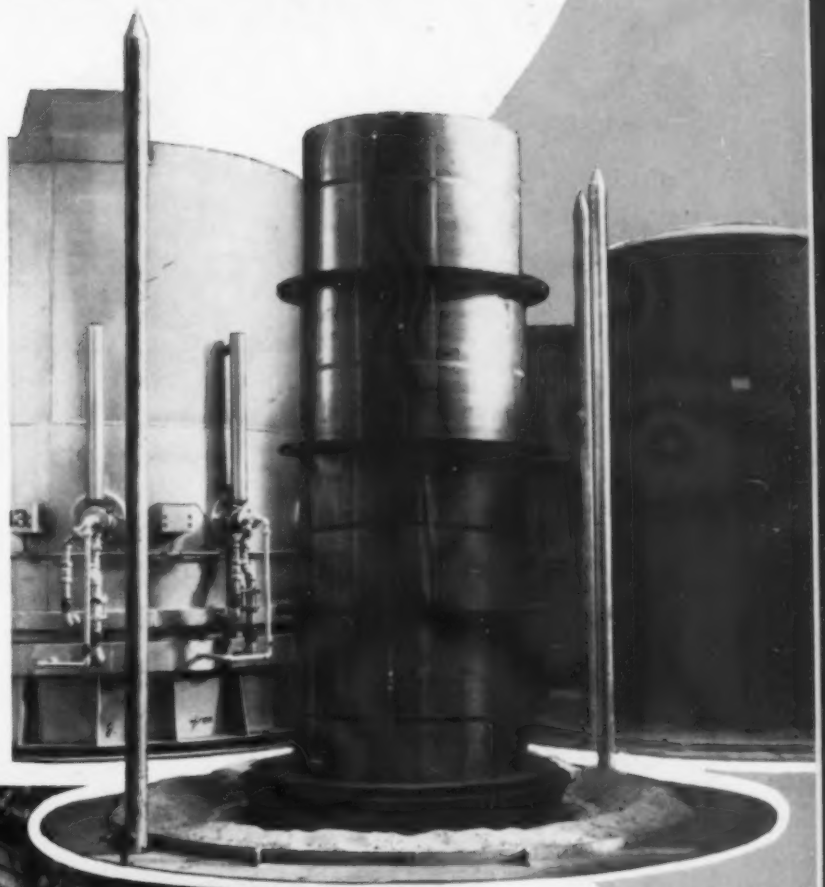
FOLLANSBEE STEEL MOVES OFFICES

▲ Only a few blocks from where the company was founded 141 years ago, Follansbee Steel Corp. has just taken up new headquarters in the Gateway Center of Pittsburgh, Pa. It was the first time the firm had moved their general offices in nearly half a century, and they only had to move across the street. The building Follansbee occupied for almost 50 years at Third and Liberty Avenues is to be torn down to make way for Pittsburgh's progress.

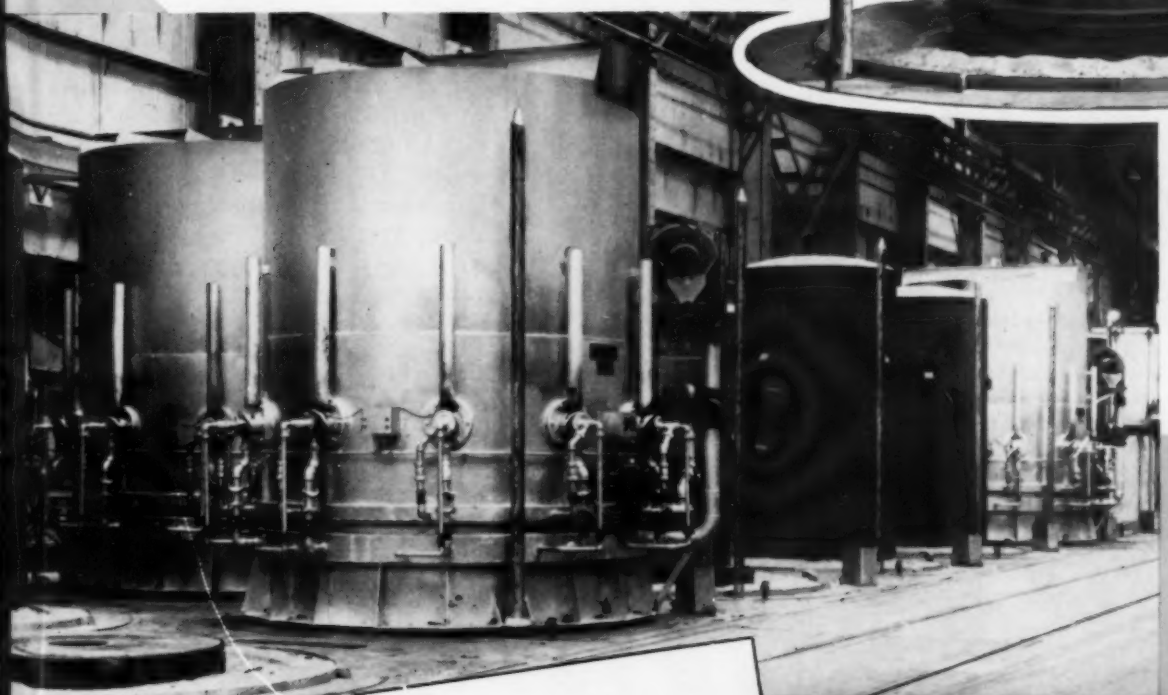
Follansbee is one of Pittsburgh's oldest companies, evolving from a firm established in 1812 as a business dealing in "block tin, ingot copper, spelter, antimony, sheet zinc, sheet iron and tin plate."

When the Follansbee family first entered the organization, in 1878, it bore the name, Park, Scott & Co. In 1894, the business was reorganized

WILSON SINGLE STACK PORTABLE BASE ANNEALING FURNACES



● Here — at the Tennessee Coal & Iron Division of United States Steel Corporation, Birmingham, Alabama, is the first large installation of Wilson single stack portable base furnaces for annealing strip coils 72" in diameter, piled 156" high.



There are 5 Furnaces and 16 Bases in this installation.

Lee Wilson

ENGINEERING Co., Inc.

20005 WEST LAKE ROAD • CLEVELAND, OHIO
Telephone ED-1-6600

BELL TYPE FURNACES ★ RADIANT TUBE HEATING ★ ANNEALING PROCESSES

MOHR *Heavy-Duty*
REVOLVING DISTRIBUTOR
for Blast Furnaces

Sets New Standards in Performance, Lower Maintenance and Longer Life

Dependable operation and reduced maintenance are engineered into the Mohr Heavy-Duty, High-Pressure Revolving Distributor. Its outstanding performance results from Mohr's exclusive improved gas seal and other advanced structural features. Lower maintenance and longer life are achieved through innovations in design. For example, greater bearing area is provided. A special hopper seat eliminates replacement of the complete hopper. Heavier construction and protection against wear contribute to less down-time and longer life.

The record of no repairs during a furnace campaign proves the outstanding performance of Mohr Revolving Distributors in service.

The complete details on this Mohr development are presented in an illustrated bulletin which will be sent to you on request.

Engineers
Fabricators
Contractors
Since 1881

JOHN MOHR & SONS
3200 East 96th Street—Chicago 17, Illinois

under the name Follansbee Brothers Co. and its capitalization was only $60,000 — not enough to keep the present firm running 24 hours.

From its new Gateway Center headquarters, at 140 Stanwix Street, the Follansbee firm directs operations of its principal manufacturing plant, a metal warehousing organization, a large subsidiary company manufacturing enameledware and household utensils, and a sheet metal specialty division producing stove pipe, milk cans and pails, ice cream cans, and metal stampings. The company's products are marketed through sales offices in 15 U. S. and two Canadian cities.

COLORADO PLANT BUILDS GIANT COOLING TOWER

▲ A gigantic cooling tower is being erected by Colorado Fuel and Iron Corp. at its Pueblo, Colo. plant. The tower, one of the most modern and efficient known, is being installed to cool all water used in the operation of the power plant. When completed, it will be capable of cooling water from a temperature of 95 F to 80 F at the rate of 66,000 gpm.

Redwood imported from California is the only material being used in the construction of this tower. Colorado Fuel and Iron engineers say that redwood is best because it does not split or crack when subjected to alternate wetting and drying. Tons of redwood timbers arrive pre-cut, notched, and match-numbered, and they are assembled in a jig-saw of inter-laced lath without the use of nails and screws. The intricate pattern of criss-crossed lath is designed so that the tower will support not only its own weight but also the pressure of hurricanes, earthquakes, and winds of 100 miles per hour.

The tower is 193 ft long, 63 ft wide, and 40 ft high. Water pumped in at the top will trickle through the lath, breaking into fine showers, and, as it falls, it is subjected to air circulation from eight fans, 22 ft in diam. As a fire precaution the tower is covered with asbestos cement board.

HEATING ENGINEERS RECEIVE TRINKS AWARD

▲ The Trinks Industrial Heating Award, the nation's top honor for the industrial heating and related fields, was presented on May 5 to four engineers.

The four honored were Harry H. Harris, president, General Alloys Co., Boston, Mass.; Carl I. Hayes, president, C. I. Hayes, Inc., Providence, R. I.; Carl F. Mayer, president, Carl Mayer Corp., Cleveland, Ohio; and J. Spotts McDowell, technical assistant to the president, Harbison-Walker Refractories Co., Pittsburgh, Pa.

The Award is bestowed annually by a judges' panel, among candidates nominated by the industry, for the most notable contributions to economic or scientific progress in industrial heating. It was established in honor of Dr. Willibald Trinks, professor emeritus of Carnegie Tech and world authority on industrial heating problems.

The current Awards, large, gold-bronze medallions bearing Dr. Trinks' likeness, were presented by I. Stanley Wishoski, editor of "Industrial Heating" magazine.

Mr. Harris, he said, was honored for his pioneering in heat resisting alloys and alloy casting designs for continuous furnaces. The award recognized Mr. Hayes for his developments in electric furnaces and protective atmospheres. Mr. Mayer was selected for his design and engineering of industrial ovens. An authority on silica refractories, Mr. McDowell qualified as a leading authority and developer of modern theory in the refractories industry.

Judges on this year's Award Committee were Dr. Trinks; Dr. John C. Warner, president of Carnegie Institute of Technology; T. J. Ess, managing director of the Association of Iron and Steel Engineers and editor of Iron and Steel Engineer; Carl L. Ipsen, executive vice president of the Industrial Furnace Manufacturers Association; and Harold A. Strickland, vice president—engineering, Hotpoint, Inc.

DISCOVER NICKEL DEPOSIT IN CUBA

▲ Discovery in Cuba of a large deposit of nickel ore, a major new source of this critically short metal, was announced recently by Freeport Sulphur Co.

Extensive exploration recently completed has established the existence, the company said, of at least 40,000,000 tons of nickel ore in the vicinity of Moa Bay about 500 miles east of Havana. Freeport officials believe that, except for certain deposits in Canada, the Moa Bay ore bodies constitute the most important proven source of nickel anywhere in the free world.

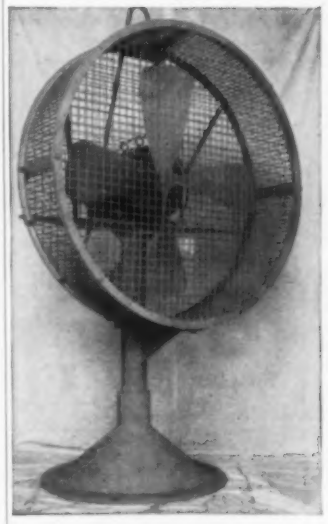
The company will build a pilot plant for the recovery of nickel and also of cobalt, another scarce and urgently needed metal contained in the ore.

Freeport was the first U. S. company to mine and process nickel on a large scale and was responsible for the development of new methods for the recovery of this metal from ores previously unusable. A Freeport subsidiary, Nicaro Nickel Co., designed, built and operated for the United States Government in World War II a $32,000,000 plant at Nicaro, Cuba, to recover nickel in the form of nickel oxide from ores owned by the Nicaro company. After the outbreak of the

IS HEAT SLOWING UP YOUR WORKMEN?

TRUFLO CRANE CAB FANS
For cooling interiors of crane cabs and other confined areas. Adjustable both horizontally and vertically. Four blade type, 12 and 18 in. sizes.

Keep them COOL with TRUFLO FANS



TRUFLO PORTABLE COOLING FANS
Easily portable. Help keep efficiency high where work is hottest. 12 to 36 inch diameters.

Production suffers when workmen are overheated. Steps begin to drag, efficiency falls.

Now, when speedy production is vital, Truflo Fans can help keep your workmen on their toes. All Truflo Fans are designed and built correctly to put fresh cool air *in large volumes* exactly where it is needed. Perfectly-balanced shafts and blades give more air per h.p. . . . strong steel frames stand up longer under hard use . . . rugged wire guards protect men against injuries.

All of the following types can help beat the heat, keep production moving in your plant. Write for illustrated literature.

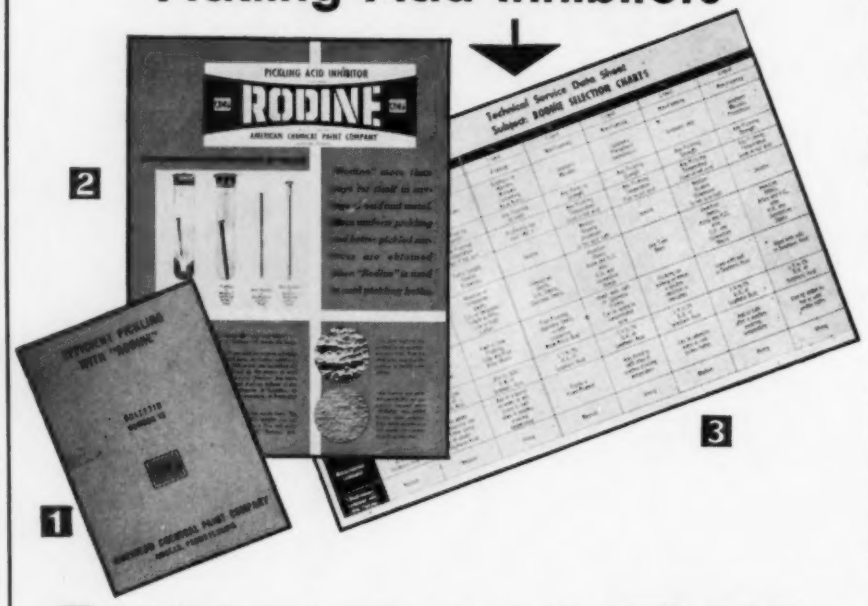
PORTABLE COOLING FANS
CRANE CAB FANS • WALL FANS
EXHAUST FANS • BLOWERS
ROOF VENTILATING FANS
PENT HOUSE FANS

TRUFLO FAN COMPANY
245 MAIN ST., HARMONY, PA.

New Data Available on . . .

RODINE®

Pickling Acid Inhibitors



1 The standard reference work on pickling, "Efficient Pickling With RODINE" — Bulletin Number 13 — is now available in a new, revised edition.

2 This new 4-page general descriptive folder presents essential information on "Rodine" pickling acid inhibitors.

3 The recently revised "RODINE SELECTION CHART" gives characteristics of and uses for typical "Rodines" used with sulfuric and muriatic acids. Technical Service Data Sheet No. 13-1-1-4.

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Korean war the plant was reactivated and is now being operated for the government by another operator.

The new deposit at Moa Bay averages about 1.35 per cent nickel and about 0.14 per cent cobalt. These ore bodies are larger and more valuable than the Nicaro deposits which are now supplying the government plant.

J & L TO EXPAND ATLANTA PLANT

▲ Expansion and modernization of its container plant in Atlanta, Ga., was announced by the Container division of Jones & Laughlin Steel Corp., which will be operating in a new plant there in the Fall. The corporation's present manufacturing plant, a four-story building located at 410 Marietta Street, N. W., has been sold to Chattahoochee Industrial Warehouse, Inc.

The new plant is to be a one-story, modern industrial building, containing in excess of 100,000 sq ft of space. It is being built along Chattahoochee Avenue in the new Atlanta industrial district, on a plot of ground containing approximately 8.3 acres.

BUILDS SOUND-TESTER FOR TRANSFORMERS

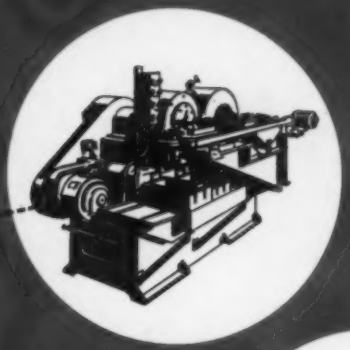
▲ General Electric Co. is now constructing at Pittsfield, Mass., a million-dollar tool for making quieter power transformers at a lower cost.

This new facility, a sound test building and special equipment, will be used to noise-test transformers. Test results are expected to point the way to reducing vibrations in even the largest units.

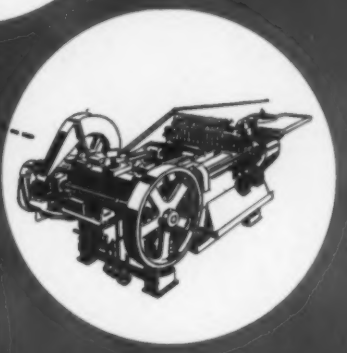
The sound chamber of the test building will be "the quietest room in the world for its size." The chamber will be 56-ft wide, 66-ft long and 49-ft high. It will be large enough to test any transformer being built today and any anticipated within the next decade.

Four and a half feet thick double walls will make the chamber completely soundproof. The walls will be composed of concrete, fiberglass, masonry, a layer of copper shielding, a 6-in. compartment of air space and, on the inside, 28-in. wedges of fiberglass encased in wire cloth. A working surface will be provided by interlaced airplane cables held in place by 400-lb

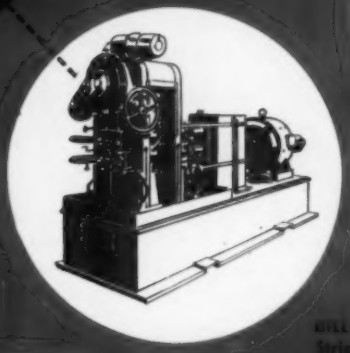
5 KINDS OF WATERBURY FARREL ANSWERS TO YOUR MASS PRODUCTION PROBLEMS



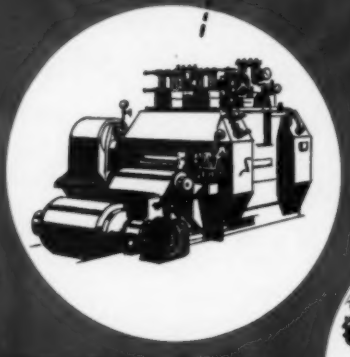
COLD PROCESS BOLT & NUT MACHINERY — Headers (all types) • Rivet Machinery • Trimmers • Thread Rolling Machines • Slotters • Nut Formers and Tappers, etc.



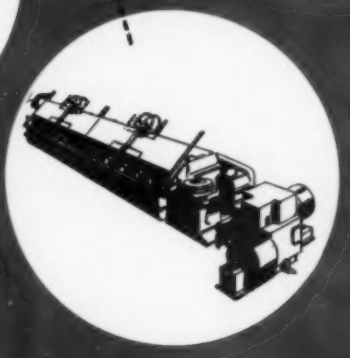
POWER PRESSES — Crank, Cam and Toggle; also Rack and Pinion Presses • Eyelet Machines • Multiple Plunger Presses • Horizontal and Hydraulic Presses, etc.



MILL MACHINERY — Rolling Mills: Strip, Rod, Wire Flattening, (For Ferrous and Non Ferrous Metals) • Also Slitters • Straighteners • Cut-off Saws • Coilers • Winders, etc.



SPECIAL MACHINERY — Sendzimir Mills • Small Arm Ammunition Machines • Collapsible Tube Machines • Coining Mills, etc.



WIRE MILL EQUIPMENT — Continuous Wire Drawing Machines (Upright Cone and Tandem) • Wire Flattening Mills • Chain Draw Benches • Pointers • Swagers • Bull Blocks • Straighteners • Machines • Spoolers, etc.

Within These Basic WF Equipment Lines, Individual Machines Are Custom-Engineered For Specific Applications

If your metal-working machinery problem falls into any of these five groups, there are good reasons for looking to Waterbury Farrel for the answer.

There's Waterbury Farrel's continuing engineering research with more than a century of machine building experience to draw upon. This results in soundly designed and thoroughly tested features which improve production.

There's Waterbury Farrel's world-wide reputation for rugged, long-lasting construction. This gives you the assurance that WF machines are built to provide long years of uninterrupted production.

Waterbury Farrel can custom-engineer special equipment or adapt a standard machine to fit your specific problem.

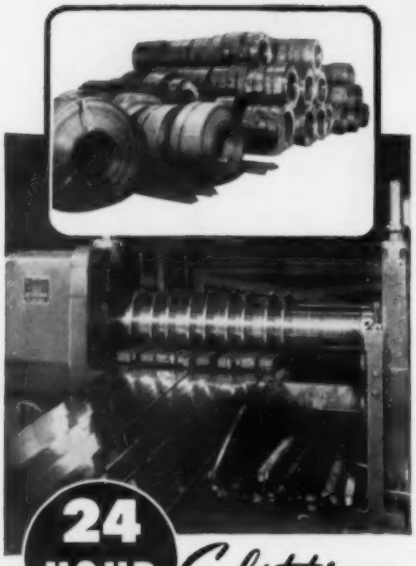
For further information, write for free booklets on any of the machines mentioned on this page or contact your nearest WF office.

HERE'S A SAMPLE of Waterbury-Farrel mass production equipment in action. This complete WF automatic production unit combines a 40-ton double-acting, upright blanking and cupping press, a conveyor feed and four 7-station horizontal drawing presses to draw 340 zinc shells per minute.

FOUNDED WATERBURY FARREL 1851

WATERBURY FARREL FOUNDRY & MACHINE CO. • WATERBURY, CONN.

Offices: Chicago, Cleveland and Millburn, N. J.



24 HOUR *Slitting Service!*

If you operate a slitter of your own, you may always enjoy this kind of service. Think what a blessing it is to be able to meet expected and unexpected needs for slit strands on such short notice—how greatly it simplifies production planning—how it eliminates production bottlenecks and minimizes strip inventories.

Then, too, when you buy strip in standard widths, your strip supply sources are more numerous. You can buy wherever you get the best delivery, price, and quality.

Slitting service now may cost you anywhere from $10.00 to $100.00 or more per ton. Even if your needs were only 50 tons per month, at an average of $20.00 per ton for slitting, the cost per year would be $12,000—an amount which alone may be more than sufficient to make a Yoder slitter highly profitable.

The Yoder Slitter Book (sent on request) analyzes and discusses the economics as well as the mechanics of slitter operation. Yoder engineers will be glad to study your needs and submit recommendations as to kind, size, and cost of suitable slitting equipment.

THE YODER COMPANY
5495 Walworth Avenue • Cleveland 2, Ohio

Rotary Gang SLITTERS — ENGINEERING YODER MANUFACTURING

compression springs attached to the walls.

Purpose of the copper shielding in the chamber walls will be to prevent radio waves from interfering with the sound tests.

Attached to the sound chamber will be a large vestibule to protect the chamber from inclement weather when its massive 40-ton doors are open. The doors will be insulated with fiberglass and will have longitudinal compartments filled with sand.

Transformers will be conveyed to the sound chamber on a specially-designed transfer car.

Controls for the sound tests will be in an adjoining structure. Another structure will house three power transformers which will be used in providing power for the testing.

ESTABLISH ATOMIC POWER DIVISION

▲ Babcock & Wilcox has announced the establishment of an Atomic Power Division. Babcock & Wilcox has been active in nuclear work since 1943, having been engaged in the Manhattan project which resulted in the development of the first atomic bomb. It played a large part in engineering work on the reactor at the Brookhaven Laboratory on Long Island, has done, and still is doing, work on the development of the "atomic engine" for the nuclear powered submarines, and is doing advance studies on the application of atomic power to larger Navy ships. Babcock & Wilcox is also actively associated with Detroit Edison and Dow Chemical companies in work of applying atomic power to the generation of electricity.

The company has been building steam generating equipment since 1867 and since the utilization of nuclear reaction requires, basically, that heat be transferred to steam power then to electrical energy, the company is in a natural position to contribute significantly in the atomic power field.

JOY MFG. CO. ACQUIRES ENGINEERING FIRM

▲ Barnes and Reinecke, Inc., Chicago, Ill., engineering company, specializing in mechanical research and development, was acquired recently by Joy Manufacturing Co., Pittsburgh, Pa.

According to Joy Manufacturing, Barnes and Reinecke, who made the announcement jointly, Barnes and Reinecke will continue to operate under its present name and with its present personnel as a subsidiary of Joy.

Headquartered at 230 E. Ohio Street near the business heart of Chicago, Barnes and Reinecke is a 19-year old enterprise. After an initial background embracing both engineering development and industrial design for some years, the firm gradually concentrated on the former in response to the growing need for research and development services. Its staff presently included 100 people. In addition to engineering facilities, the physical plant includes a testing laboratory and a prototype assembly area.

INSUL-MASTIC CORP. APPOINTS AGENT

▲ Insul-Mastic Corp. of America has announced the appointment of S. W. Kopperman, Inc. of Philadelphia as a licensee to handle the sale and application of Insul-Mastic protective coatings in that area.

S. W. Kopperman, Inc. are well known industrial painting contractors who are skilled in surface preparation. The company is prepared now to spray the heavy coatings on tanks, ducts, vessels, pipes and wherever corrosion may occur. They will also employ the coatings to vaporseal thermal insulation and to waterproof buildings.

DONATE OVERTIME PAY TO COMMUNITY FUND

▲ Unique among fund raising plans is the employees' "Good Neighbor" plan at Crouse-Hinds Co., Syracuse, N. Y. For the fifth time in as many years more than 90 per cent of all workers have reported for work on a Saturday and have contributed the morning's earnings at overtime rates to the Good Neighbor Fund.

On March 7, the "Half Day's Labor Makes a Good Neighbor" Plan earned approximately $25,000.

The chief advantages of this plan are that (1) every man and woman participates on an equal basis of five hours' time, (2) no payroll deductions, (3) all community welfare fund raising responsibilities taken care of at one time.

AJAX DIHEDRAL couplings

Cut line-up time to minutes...

And that means you cut high down-time costs. Exclusive Ajax Dihedral tooth shape takes care of necessary misalignment between driving and driven shafts.

Handle misalignment far beyond capacity of conventional flexible couplings.

Seals keep lubricant in and dirt out.

Write for full information.

features

Least backlash

Most misalignment capacity

All gear teeth hardened to 50-55 Rockwell C

AJAX FLEXIBLE COUPLING CO. INC. • WESTFIELD, N. Y.

Representatives in Principal Cities

For the fifth consecutive year workers at Crouse-Hinds Co., Syracuse, N. Y. donated their Saturday morning earnings to the Good Neighbor Fund. Designed to combine all community fund raising activities, the plan totalled nearly $25,000 this year with more than 90 per cent of the employees participating.

A board of twelve trustees is elected by the 2200 employees to manage and allocate the funds which are contributed to Community Chest, American Red Cross, March of Dimes and Christmas Toy Fund, a local project.

Each year on Good Neighbor Day representatives from benefiting agencies come to tour the foundry, factory and office of the Syracuse manufacturer of electrical equipment. They learn at first hand about the jobs these employees do to raise the funds to support community welfare, recreation and character building agencies. Workers are congratulated on their efforts, too.

The Good Neighbor Plan as worked out by Crouse-Hinds employees is truly a federated plan, doing away with all other in-plant solicitations for community welfare funds.

APPOINT AGENT FOR NORTHERN OHIO

▲ The appointment has been made of H. K. Stevenson, Inc., Union Commerce Building, Cleveland, Ohio, as sales representatives for northern Ohio, representing Zurn Continental Services, Inc., the exclusive sales agents for American Flexible Coupling Co., Erie, Pa., U.S.A. The firm will provide sales engineering service for both "Amerigear" and "American" Flexible Couplings for power transmission.

H. K. Stevenson, Inc., is managed by Hugh K. Stevenson and Charles A. Weed.

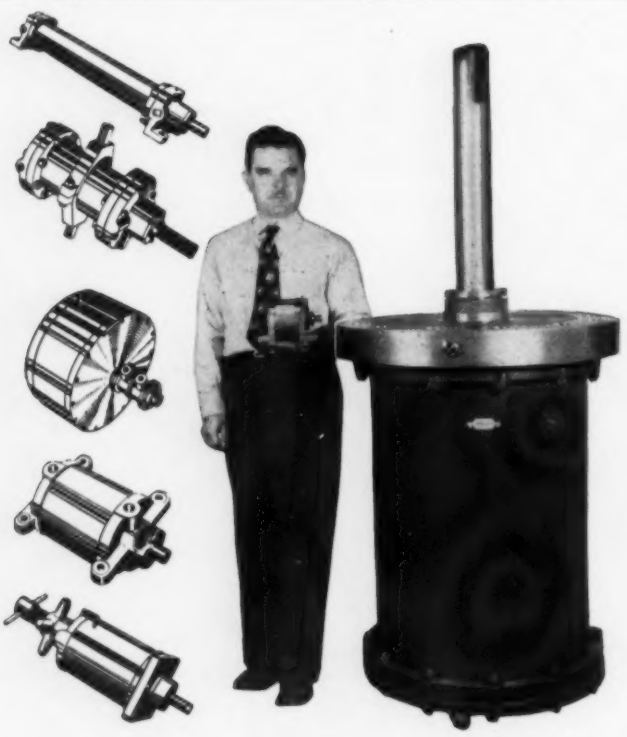
ESTABLISH OFFICE IN SAN FRANCISCO

▲ Establishment of a San Francisco, Calif., branch office of the Westinghouse Electric Corp. has been announced. The new office, created in line with national changes in the company's district organization pattern, will provide better service to Westinghouse apparatus customers in northern California and western Nevada. The new branch will be comparable to other branch offices in Los Angeles, Calif., Seattle, Wash., and Salt Lake City, Utah, and its operation will relieve Pacific Coast district staff managers of direct local supervisory duties.

AWARD BARGE HARBOR CONTRACT TO DRAVO

▲ Contract for improvement of the Harmar Coal Co.'s barge harbor on the Allegheny River at Harmarville, near Pittsburgh, Pa., has been awarded to Contracting Division of Dravo Corp

The project will consist of installing 25 steel sheet pile cells. Two of these,



INFORMATION *on the complete line of Anker-Holth products is given in this bulletin. Free on request.*

What's your problem in power motion?

There's an Anker-Holth cylinder to solve it!

• Advanced designs of Anker-Holth power cylinders in a wide range of sizes and types are available to solve your problems involving push, pull, lift or lowering action. If standard cylinders aren't the answer, Anker-Holth matches your needs with special designs.

For help in engineered cylinder power . . . air or hydraulic . . . write Anker-Holth Division of The Wellman Engineering Company, Dept. E-2, 2723 Conner St., Port Huron, Michigan.

Anker-Holth
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WELLMAN

Division of
THE WELLMAN ENGINEERING COMPANY

Wellman will build it

Special Cranes
Skip Hoists
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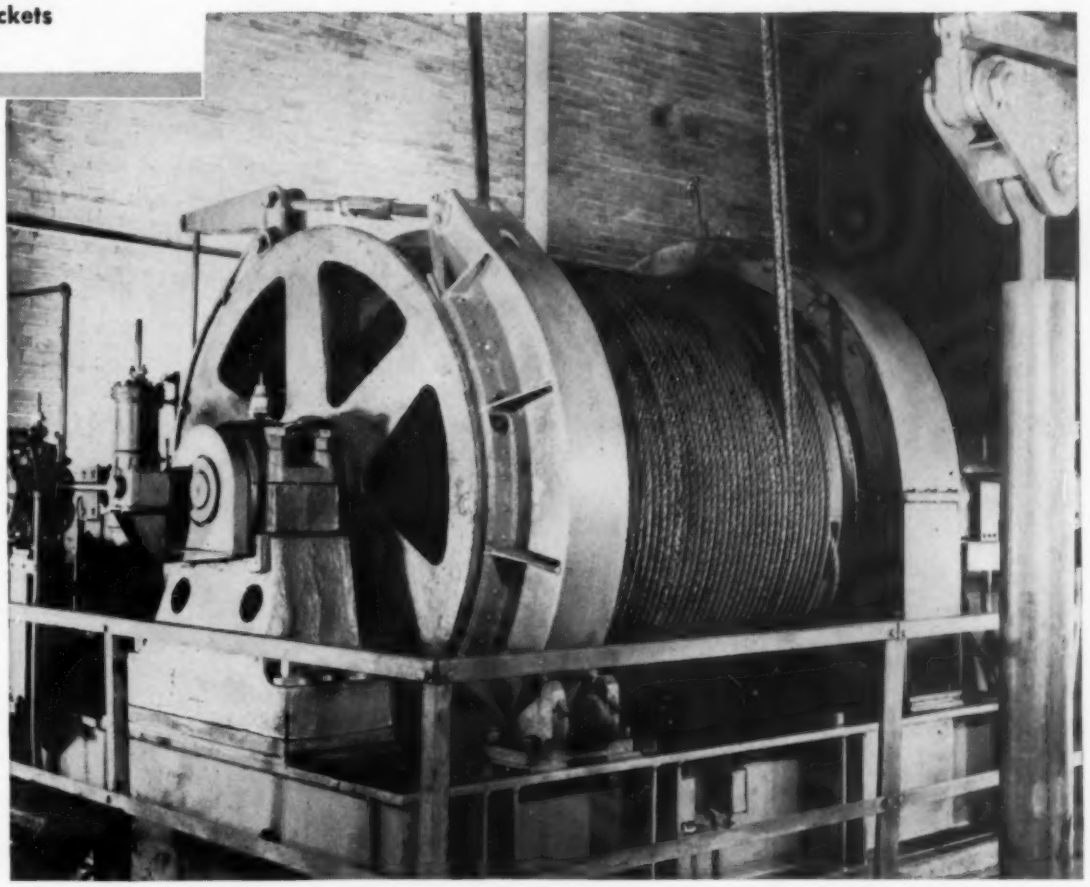
Charging Machines
Forging Manipulators
Car Dumpers
Gas Flue Systems
Gas Reversing Valves
Coke Pushers
Mine Hoists
Ore and Coal Bridges
Clamshell Buckets

Wellman skip hoists

Speed blast furnace materials handling

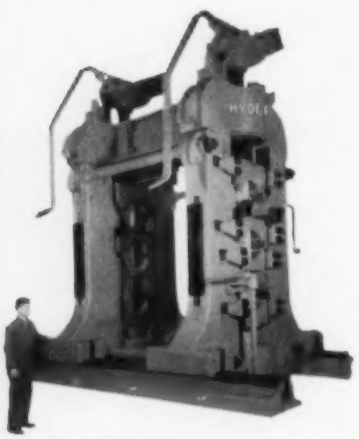


Wellman 6-ft., Single Drum Blast Furnace Skip Hoist.

● Wellman Skip Hoists are recognized throughout the steel industry for their smooth, reliable operation. They incorporate design advancements and engineering recommendations based on many years of proved performance. Wellman equipment for steel mills is backed by more than half a century of experience in designing and building for economical service.

THE WELLMAN ENGINEERING COMPANY

7000 CENTRAL AVENUE • CLEVELAND 4, OHIO

Hyde Park
RED CIRCLE Rolls ALLOY-CHILLED
Rolling Mill Equipment
Outstanding in quality and in performance Hyde Park Rolling Mill Equipment has enjoyed the respect of the industry for more than fifty years.

Bar Mills
Merchant Mills
Sheet and Strip Mills
Pinion Stands
Roller Tables
Reduction Drives
Stretcher Levellers
Guillotine Shears
Sheet Mill Shears
Roll Lathes
Special Machinery
Machine Work
Hyde Park
FOUNDRY & MACHINE CO.
Hyde Park, Westmoreland County, Pa.
ROLLS
ROLLING MILL MACHINERY
GREY IRON CASTINGS

each 26 ft in diam, will provide foundations for an unloading crane and coal hopper. The balance of cells in the inner harbor will be constructed to provide for docking of coal barges for both loading and unloading.

In the outer harbor, which will have capacity for mooring 24 barges, a new 26-ft ice breaker cell and several barge mooring posts will be constructed.

TO ACQUIRE CAPITAL SHARES OF ROSS CARRIER

▲ Clark Equipment Co., Buchanan, Mich., and Ross Carrier Co., Benton Harbor, Mich., have announced that an agreement has been entered into with members of the Ross family owning more than 85 per cent of the Ross Carrier Co., under which Clark would acquire the capital shares of Ross Carrier Co., owned by them and such other shareholders as become parties to the agreement. Michigan Power Shovel Co. is a subsidiary of Ross Carrier Co.

Under the terms of the agreement, the shareholders of Ross will receive 69 shares of authorized but unissued common stock of Clark in exchange for each share of the outstanding 1858 shares of common stock of Ross. Ross has only the one class of stock outstanding.

ANNOUNCE CHANGE IN FIRM NAME

▲ Industrial Equipment Co., 315 N. Ada Street, Chicago 7, Ill., announces that the firm name has been changed to Industrial Crane & Hoist Corp. The firm name has been changed to better identify Industrial Crane & Hoist Corp. with the cranes, runways and hoists that it engineers, manufactures and sells throughout the United States.

DUMAS STEEL CORP. OPENS NEW WAREHOUSE

▲ Dumas Steel Corp., Pittsburgh, Pa. will open a new warehouse at Marietta, Ga. The warehouse will be located in the McNeal Building on Sessions Street.

The warehouse will serve principally small manufacturers in seven Southeastern states including Alabama, Georgia, Tennessee, North and South Carolina and Mississippi. It will purchase its stock insofar as possible from Southern steel manufacturers, but will ship in from the North, products beyond the range of manufacture of Southern producers.

ANNOUNCE FORMATION OF ENGLISH BRANCH

▲ The formation of Integra-Leeds & Northrup Ltd., Birmingham, England, was jointly announced by Leeds & Northrup Co., Philadelphia, Pa., and S. A. Integra, Liege, Belgium.

The new firm succeeds to the business formerly conducted in Birmingham under the name of The Integra Co., Ltd., which was a branch of the Liege firm and for some years has been the English agent for L&N products. That business will be expanded to include the manufacture of the products of both Leeds & Northrup Co. and S. A. Integra. Ownership of Integra-Leeds & Northrup Ltd. is shared by Leeds & Northrup Co. and the owners of the former Integra Co., Ltd.

REMINGTON ARMS NAMES NATIONAL DISTRIBUTOR

▲ Appointment of the Nelson Stud Welding Division of Gregory Industries, Inc., as a national distributor for the Remington stud driver and fastener studs was announced by Remington Arms Co., Inc., Bridgeport, Conn.

Remington equipment and studs are being carried in stock at the Nelson Stud Welding direct factory branch warehouses in Philadelphia, Chicago and Oakland, Calif., as well as at the company's plant in Lorain and arrangements are being made for stocking at other Nelson field offices.

NORTON CO. MOVES NEW YORK OFFICE

▲ The New York, N. Y., domestic sales offices of the Abrasive Division, Grinding Machine Division, and Refractories Division of Norton Co., Worcester, Mass., formerly of 61 Broadway, have moved to Green and North Street, Teterboro, N. J.

Their new headquarters at the Behr-Manning warehouse and office at Teterboro (a Norton Co. affiliate), have been established to improve service to customers in the New York

industrial area. Expanded telephone coverage, ample parking facilities, and being generally closer to users of grinding wheels, grinding machines and refractories, makes this a more accessible location.

VOTE TO SHORTEN COMPANY NAME

▲ Stockholders of Combustion Engineering-Superheater, Inc., recently voted to shorten the company name to Combustion Engineering, Inc. At the same time the board of directors elected the following officers to new posts: Joseph V. Santry, president, was elected chairman of the board and will continue as chief executive officer; Samuel G. Allen retired as chairman of the board but will continue as chairman of the executive committee; Martens H. Isenberg, executive vice president, was elected president, succeeding Mr. Santry; George D. Ellis, vice president and controller, was appointed vice president in charge of finance, succeeding Harold H. Berry who has reached the retirement age. Mr. Berry will continue as a director.

PLAN FALL OPENING OF SCRANTON PLANT

▲ Now under construction in Scranton, Pa., a new manufacturing plant of Federal Electric Products Co., Newark, N. J. is scheduled to begin operations in September.

The three-million-dollar plant will consist of an ultra-modern one-story industrial structure covering 132,000 sq ft, with an adjacent administration and research building of 30,000 sq ft. The building site is a 32-acre tract of land.

BREAK GROUND FOR ILLINOIS PLANT

▲ Directors and officials of Dearborn Chemical Co. attended a groundbreaking ceremony recently to begin construction of the first building of the company's new plant, which will be located on approximately 90 acres in Lake Zurich, Ill. Construction of this first unit is part of a long-range building and expansion program which will continue for several years. It is anticipated that the first unit will go into actual production some time in November of this year.

Engineer answers vital questions about the strongest wire rope made—Flattened Strand

Why does Hercules® Flattened Strand wire rope continue to outperform round strand rope by 2 to 1 or more? Can you use it? Here, Walter C. Richards, chief engineer, A. Leschen & Sons Rope Co., tells you.

More and more wire rope users are continually experiencing or hearing about spectacular performances of Hercules Flattened Strand wire rope. The explanation is clear.

First, Hercules Flattened Strand is a Super-rope because it packs 10% more steel than any round strand rope of the same size. It's 10% stronger... 10% safer.

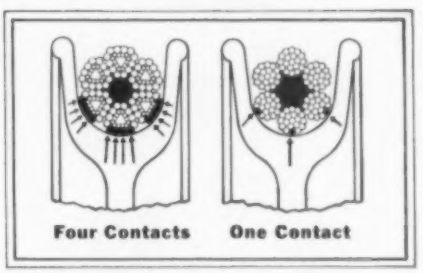
Second, Hercules Flattened Strand wears longer and more evenly. That's because there are four wires per strand contacting sheave grooves instead of one.

Third, Hercules Flattened Strand resists crushing and internal strand-cutting, because strands rest snugly against each other, keystone fashion, with less internal pressure or friction.

Fourth, Hercules Flattened Strand prolongs its own life and the life of equipment, because the relatively smooth surface of the rope prevents corrugating and wear on sheave grooves.

Can you use it?

It's a known, proved fact that no other wire rope made can equal Flattened Strand on applications such as hot ladle cranes, skip hoists, and dredge ropes. It is also best on a variety of other equipment both large and small. For many uses, it is truly a Super-rope.



With Flattened Strand, notice how four wires per strand contact sheave grooves —reducing rope and equipment wear.

But, the question is, can *you* use it to advantage? That can be answered only by a qualified wire rope engineer who is thoroughly acquainted with the characteristics and proper uses of Flattened Strand rope.

Check with the authority

That means, check with Leschen. It's wise to do so because Leschen pioneered and perfected Flattened Strand wire rope. Leschen developed special machines to make it. Leschen conducts continuing research on correct uses. Leschen is the authority.

If you discover you can use this Super-rope—Hercules Flattened Strand—you'll soon begin saving time, labor and money. Why not investigate *now?*

Hercules Flattened Strand wire rope made by
A. LESCHEN & SONS ROPE COMPANY
St. Louis 12, Missouri

In business only to make wire rope . . . better wire rope . . . since 1857

Copyright, A. Leschen & Sons Rope Co., 1953

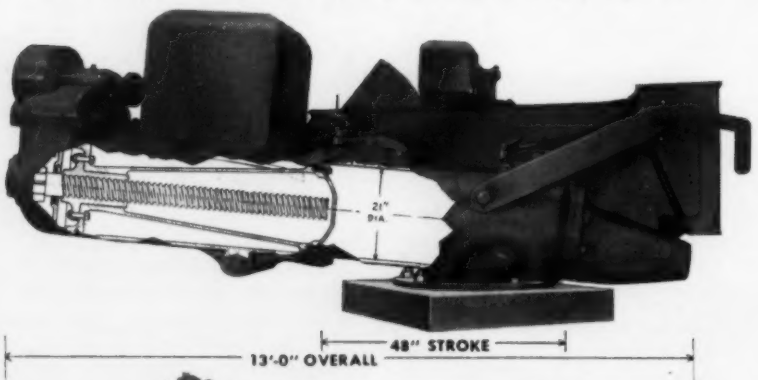
The Power you need

FOR UNIFORM
LONG TAP HOLES

Bailey ENGINEERS

CLAY GUN

Power, precision and safety in plugging blast furnace tapping holes are secured with the Bailey Clay Gun. The powerful, motor-driven screw provides the piston pressure necessary for maintaining long tapping holes. The Gun is supported from a pedestal by heavy linkage, and is swung into position by a positive motor drive which forces the nose into position with unfailing accuracy. Hundreds of installations testify to the safety and dependability of the Bailey Clay Gun.



WILLIAM M. Bailey COMPANY
ENGINEERS
LEADERSHIP THROUGH QUALITY
1221 BANKSVILLE ROAD PITTSBURGH 16, PA.

LEWIS TO BUILD COLD ROLLING MILLS

▲ The Lewis Machinery division of Blaw-Knox Co., Pittsburgh, Pa., has received an order from the American Brass Co., Waterbury, Conn., for two 10 in. and 29 in. x 36 in. four-high reversing cold rolling mills, complete with auxiliary equipment, for installation at Torrington, Conn.

COMPANIES ANNOUNCE CANADIAN AFFILIATE

▲ The Round Chain Companies, a group of 11 affiliated companies throughout the United States, announces the establishment of a Canadian affiliate, Round Chain Co. of Canada.

Covering 12,000 sq ft, the new chain-making facilities are located in Brampton, Ontario, 27 miles west of Toronto. They will make available to Canadian consumers all products manufactured and distributed by Round Chain Companies.

PURCHASE ASSETS OF LEADER ELECTRIC

▲ The purchase by the Benjamin Electric Mfg. Co. of certain assets of the Leader Electric Co., Chicago, Ill., was announced recently. The Leader line will be manufactured and sold by the Leader Division of the Benjamin Electric Mfg. Co.

Expansion of facilities for the manufacture of the Benjamin company's Leader line at the Benjamin 77-acre plant in Des Plaines, Ill., is being undertaken immediately.

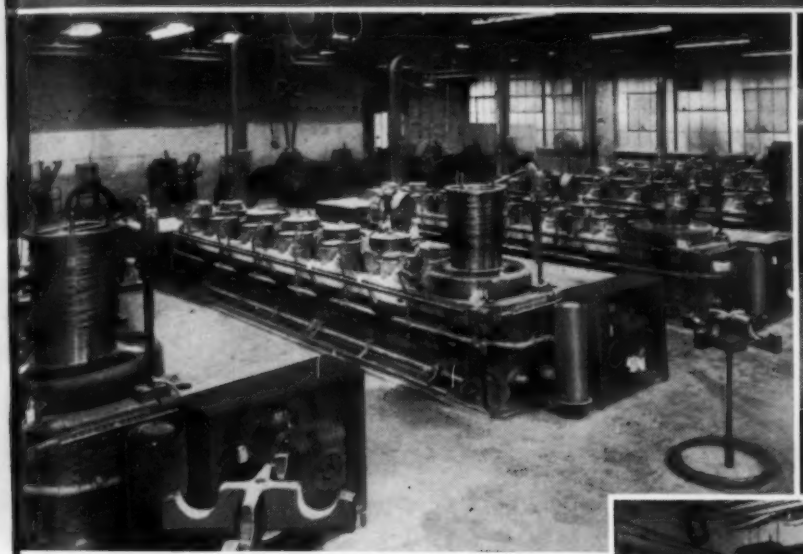
APPOINT OHIO DISTRICT SALES REPRESENTATIVE

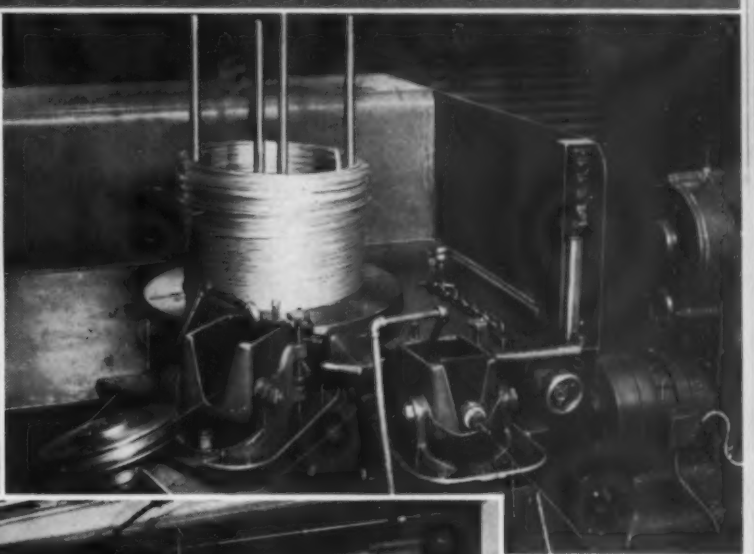
▲ American Flexible Coupling Co., Erie, Pa., has announced the appointment of Paddon Co., P. O. Box 394, Youngstown, Ohio, as sales engineers in eastern Ohio and western Pennsylvania. The Paddon Co. will provide complete sales engineering service for both American and Amerigear Flexible Couplings manufactured by the American Flexible Coupling Co.

PRODUCTIVITY

. . . the real measure of Vaughn® Performance!

VAUGHN COLD DRAWING EQUIPMENT





MOTOBLOX ®

DRAWBENCHES

MOTOBLOC ®

CONTINUOUS MACHINES

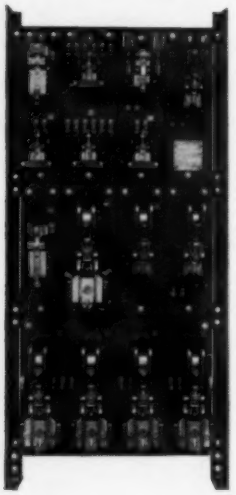
RINGBLOX ®

How much will your contemplated new equipment *produce*—in your plant, on your schedules, to your standards—and at what cost? We welcome the yardstick of PRODUCTIVITY applied to Vaughn Cold Drawing Equipment, because *Vaughn measures up!* Let us discuss the facts, at your convenience.

THE VAUGHN MACHINERY COMPANY
CUYAHOGA FALLS, OHIO, U. S. A.

COMPLETE COLD DRAWING EQUIPMENT . . . . Continuous or Single Hole . . . for the Largest Bars and Tubes . . . for the Smallest Wire . . . Ferrous, Non-Ferrous Materials or their Alloys.

This EC&M Braking Panel replaces all mechanical braking devices in southern fertilizer plant and operates satisfactorily in severe acid atmosphere.



Change-Over to Dynamic Braking Control by EC&M Results in Smoother, Safer Operation of Bucket Cranes

Dynamic Braking Bridge-Stop Control provides an all-electric braking system in which the **driving** motor also acts as the **braking** motor. Operator applies normal stopping by means of a 2-position foot switch which gives two points of dynamic braking depending upon the speed of the crane and the accuracy of stopping desired. Should power fail, dynamic braking is automatically applied to bring the crane to rest quickly, regardless of the position of the master switch.

SOMETHING had to be done! One of the cranes in this plant had partially jumped the runway when power failed at instant of plugging. Ordinary braking methods failed. Magnetically-released, mechanically-set brake wore down rapidly under hard service. Motor burnouts, shaft and gear failures spelled costly delays. Repairs were a nightmare.

So, a change-over was made to all-electric braking. This eliminated costly production delays. Maintenance became merely a routine inspection of motors and controllers. Operation became 100% satisfactory. And the operators warmed up to the smoother stopping.

Dynamic Braking Bridge-Stop Control offers advantages for your cranes. May we send you Bulletin 921-6.0?

E C & M

THE ELECTRIC CONTROLLER & MFG. CO.

2698 EAST 79TH STREET ★ CLEVELAND 4, OHIO

THE Amerigear* FULLY CROWNED TOOTH DESIGN

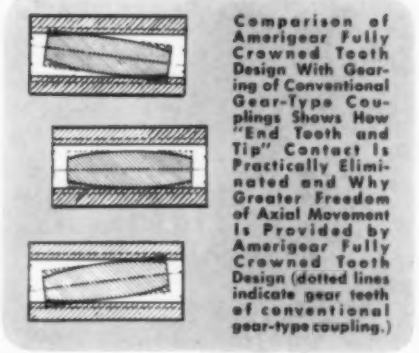
practically eliminates "End Tooth and Tip" contact
. . . gives greater freedom of axial movement

Crowned Tip Contacts Root of Internal Gear Tooth in Sleeve, Accurately Piloting Sleeve with a Ball and Socket Action.
Chamfered to Eliminate Interference with Sleeve Tooth Fillet and Allow Contact on True Flank of Gear Tooth.
Crowned Flank Carries All the Load and Provides for Correction of Lateral and Angular Misalignment Conditions.
A MAJOR IMPROVEMENT IN GEARING

Pat. & Pat. Pending

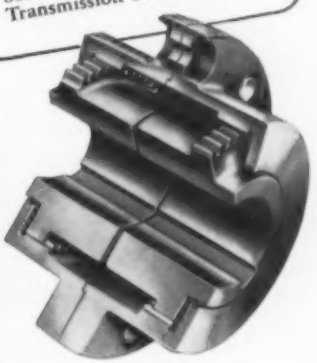
This major improvement in gearing—a fundamental improvement in gear tooth design results in these advantages: (1) Relief from extraneous stresses; (2) Crowned flanks providing for angular and lateral misalignment with back lash reduced to a minimum; (3) Torque load carried on flanks of teeth rather than on tooth edges; (4) Greater loads and higher speeds with corresponding longer life for coupling and equipment; (5) Close fit on crowned tips and flanks of teeth, inducing a ball and socket action between hub teeth and internal sleeve teeth, assure quiet and smooth performance. These advantages distinguish the Amerigear Couplings from common gear-type couplings. If your problem arises from excessive offset or angular misalignment, tight back lash requirement, space limitations, high speeds and loads, or any combination of these, the best solution is assured by use of the Amerigear Couplings with the Fully Crowned Teeth. Amerigear Engineers are available for consultation.

*Trade Mark Reg.



Comparison of Amerigear Fully Crowned Tooth Design With Gearing of Conventional Gear-Type Couplings Shows How "End Tooth and Tip" Contact Is Practically Eliminated and Why Greater Freedom of Axial Movement Is Provided by Amerigear Fully Crowned Tooth Design (dotted lines indicate gear teeth of conventional gear-type coupling.)

Amerigear*
Fully Crowned Tooth Design Solves Wide Range of Power Transmission Problems.



Oil Seals of Amerigear Couplings Are As Advanced in Design, Performance, and Effectiveness As Is the Amerigear Fully Crowned Tooth.

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AMERICAN FLEXIBLE COUPLING COMPANY

ERIE, PA., U. S. A. *Originator of the Amerigear Fully Crowned Tooth*
Sales Offices in Principal Industrial Centers

In Canada: Canadian Zurn Engineering, Ltd. • 2052 St. Catherine St. W., Montreal 25, P. Q.

American Flexible Coupling Co., Erie, Pa., U. S. A.
Please send me further information regarding AMERIGEAR COUPLINGS with the Fully Crowned Teeth and Catalog No. 501.

Name ..... *Title* .....
Company .....
Address .....
City ..... *State* .....
Please attach to your business letterhead.

REFRACTORIES — Melting... Cutting Out...?

RUNOUT TROUGHS

CINDER NOTCH LINERS

CINDER NOTCH PLUGS

MOLD PLUGS

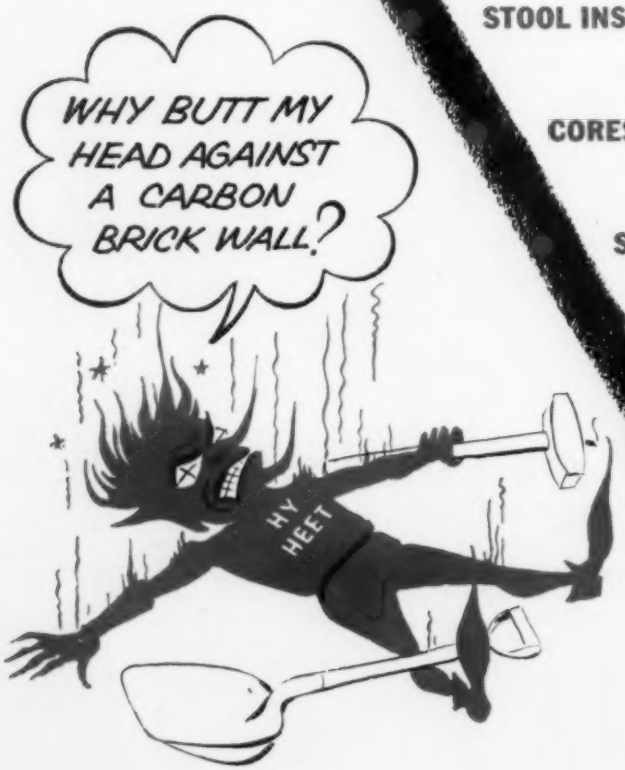
BEDS AND TRAYS

SPLASH PLATES

STOOL INSERTS

CORES

SKIMMER PLATES



Stock NATIONAL Carbon Brick and Shapes for Low-Cost Maintenance

"National" carbon blast furnace linings, of course. But HAVE YOU THOUGHT ABOUT CARBON for the other hot-spots where ordinary refractories conk out from high temperatures or slag-cutting? CARBON, the refractory, has no melting point and low affinity to molten metal and dross. In fact, even in *unfavorable* atmospheres, CARBON frequently outperforms other refractories on a length-of-life or cost-of-replacement basis.

Here are some of the places where "National" carbon and graphite can follow up their good work in the furnace... improve production, deflate maintenance cost, increase product quality and better the safety of equipment and personnel.

ON NEW APPLICATIONS OF CARBON, CONSULT NATIONAL CARBON'S ENGINEERS FOR PROPER GRADE AND DESIGN.

The term "National" is a registered trade-mark of Union Carbide and Carbon Corporation

NATIONAL CARBON COMPANY
A Division of Union Carbide and Carbon Corporation
30 East 42nd Street, New York 17, N. Y.

District Sales Offices:
Atlanta, Chicago, Dallas, Kansas City, New York, Pittsburgh, San Francisco

IN CANADA:
National Carbon Limited — Montreal, Toronto, Winnipeg

Personnel News...

Ernest R. Johnson has been named assistant vice president in charge of operations for Republic Steel Corp., Cleveland, Ohio. Mr. Johnson, who will oversee all the company's steel operations, succeeds **E. A. Schwartz** who has resigned. Mr. Johnson was manager of the Central Alloy District with plants in Canton and Massillon, Ohio. Succeeding Mr. Johnson as district manager will be **Oscar A. Bamberger,** assistant district manager. Mr. Johnson has been with Republic and predecessor companies since 1922. He joined Central Steel Co., Massillon, Ohio, in that year and three years later became associated with the company's metallurgical staff. He was made assistant superintendent of metallurgy in 1926 and assistant chief metallurgist in 1929. In 1930, Republic Steel Corp. was organized by a merger of a number of companies, including Central Alloy Steel Corp., a successor company to Central Steel. In 1944, Mr. Johnson was appointed chief metallurgical engineer for the Central Alloy District and in 1946 was made assistant district manager. He was appointed district manager only last September. Mr. Bamberger has been associated with Republic or predecessor companies for 34 years. He joined Central Steel in 1918. In 1921 he was transferred to the metallurgical department. In 1940, when Republic established an armor plate department, he was made superintendent of the fabricating works and in 1941 was named superintendent of mechanical maintenance of the Massillon plant. He later became superintendent of the Canton steel division and last September was named assistant district manager for the Central Alloy District.

Joseph H. Jones was appointed assistant district manager of Republic Steel Corp.'s Central Alloy District in Canton and Massillon, Ohio. Succeeding Mr. Jones as superintendent of Republic's Massillon steel plant is **Robert P. Carpenter.** Mr. Carpenter formerly was superintendent of the open hearth department at Republic's Cleveland, Ohio, steel plant. **Walter M. Farnsworth,** assistant district manager for both Republic's Central Alloy and Chicago Districts, will continue in his present capacity.

A. S. Glossbrenner, vice president in charge of operations, Youngstown Sheet and Tube Co., Youngstown, Ohio, was elected to the board of directors. Mr. Glossbrenner fills the vacancy created by the death of **Frank Purnell,** chairman of the board. Reelected were the following directors: **Leon A. Beeghly, George C. Brainard, John W. Ford, S. Livingston Mather, J. L. Mauthe, John P. McWilliams, Rollin C. Steese, Fred Tod, Jr., Walter E. Watson** and **Lewis B. Williams.**

Harold G. Rethmeyer was appointed branch manager of the newly established San Francisco, Calif., office of Westinghouse Electric Corp. Mr. Rethmeyer, who joined Westinghouse in Pittsburgh, Pa., in 1926 has been district manager of marine, aviation and transportation sales since 1948. To implement his branch office, Mr. Rethmeyer appointed four sales supervisors; **M. Wayne Scolari, George Skipton, G. Burnett Mason,** and **David Roach. Allan S. Judson** becomes branch office supervisor.

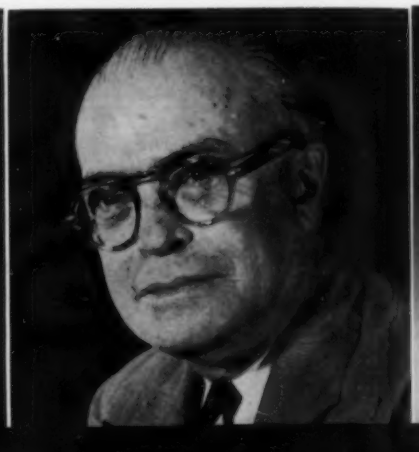
James C. Hicks has been appointed director of refractory research for Kaiser Aluminum & Chemical Corp., Oakland, Calif. Mr. Hicks succeeds the late **Leslie W. Austin.** During the past 10 years with Kaiser Aluminum, Mr. Hicks has been intimately associated with the development of the company's refractory products for basic industry, and for eight years was assistant to Mr. Austin.

Oliver G. Dumont has been named superintendent of the electrical departments at Allis-Chalmers Norwood, Ohio, works succeeding **G. C. Vogel,** who recently became general superintendent.

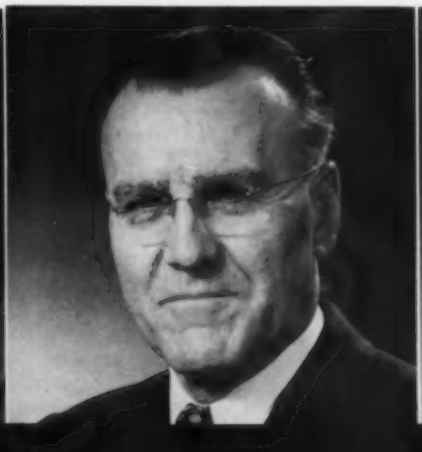
Julian D. Dickerson was appointed chief metallurgist for the Midland, Pa., works of Crucible Steel Co. of America. Mr. Dickerson replaces **George Bryer** who was recently appointed metallurgical service engineer for the Detroit, Mich. area. Previous to joining Crucible, Mr. Dickerson was chief metallurgist for Repub-

E. R. JOHNSON

O. A. BAMBERGER



J. H. JONES



R. P. CARPENTER

lic Steel Corp. at its Buffalo, N. Y., plant. He joined Republic, in Buffalo, in 1933 and worked in the open hearth and metallurgical departments. He was appointed chief metallurgist in 1940.

Preston C. Mitchell has been elected vice president of Harbison-Walker Refractories Co., and **Edward T. Hile** and **Harry H. Yeager** have been elected directors of the company. All three men will maintain headquarters in the company's general offices in Pittsburgh, Pa. Mr. Mitchell has worked for Harbison-Walker in various capacities for 31 years. He was appointed general superintendent of mines in 1939. The new directors, Mr. Hile and Mr. Yeager, both have served the company for more than 25 years. Mr. Hile has been vice president in charge of operations since 1950. Mr. Yeager has been general superintendent of operations.

Elmer J. Keller, assistant chief inspector at the Indiana Harbor, Ind., plant of Youngstown Sheet and Tube Co. has been appointed superintendent of pipe mills. Mr. Keller succeeds **Eric Jansson** who has left the company. **Emmett E. Holmgren,** inspection foreman at the hot strip mill here succeeds Mr. Keller as assistant chief inspector.

John K. Beidler, general manager of the Dravo Corp.'s Machinery Division, and **Louis P. Struble, Jr.,** general manager of the Keystone Division were elected

JOHN K. BEIDLER

vice presidents of the company. **Clifford A. Hill,** formerly controller, was elected treasurer, and **Edward T. Fitch** was named controller.

Charles B. Tillson, Jr., was named superintendent of the Crucible Steel Co. of America coal mine located at Crucible, Pa. He replaces Mr. **T. P. Latta** who retired April 1, 1953. Mr. Tillson has been serving as assistant superintendent of the mine since January 1952.

Philip J. Berg has been appointed to the Detroit, Mich., office of the Machinery division, Dravo Corp., to supervise the sale of Dravo products and projects in the state of Michigan.

Walter T. Aye was appointed assistant to the superintendent of yards and roads department of Kaiser Steel Corp., Fontana, Calif.

William B. Todd has retired as executive vice president of Continental Foundry & Machine Co., Pittsburgh, Pa. Mr Todd will continue to be a member of the board of directors of the company and serve in an

ARTHUR E. MURTON

advisory capacity. **Arthur E. Murton,** vice president of the company, has been appointed manager of the Pittsburgh office of Continental Foundry & Machine Co. to succeed Mr. Todd.

F. H. Pelletier, 1729 Santee Street, Los Angeles, Calif., will service customers of C&D Batteries, Inc., in southern California, McCormick-Morgan Co., 725 Second Street, San Francisco will handle sales and service activities in northern California; and **N. J. McCormick** will cover the general Portland, Ore. trading area. Mr. McCormick will maintain offices at 427 N. Cook Street, Portland. The northwestern territory, covering Washington, northern Idaho and eastern Montana will be handled by **C. M. Rogers** of the Industrial Products Co. Mr. Rogers will be located at 2911 First Avenue, South, Seattle, Wash.

Gilbert L. Holt has been appointed works manager of the Berwick, Pa., plant of American Car and Foundry Co. With ACF since June 1948, Mr. Holt served successively on the New York staff, as assistant district manager at the Madison, Ill., plant and at Berwick as chief industrial engineer, superintendent of the war materials department and as production manager prior to his appointment as works manager.

Thomas E. Bell was named sales manager for the Republic Flow Meters Co. For the past 20 years, Mr. Bell has been manager of the southern territory with headquarters in Atlanta, Ga. **Thomas Waldrop** has been appointed to fill the vacancy left by Mr. Bell and will become manager of the Atlanta office.

Edward J. Duffy, manager in charge of raw materials at the Kaiser Steel Corp. plant, Fontana, Calif., has

Now! Super High-Purity

OXYGEN and NITROGEN

at Amazingly Low Cost!

OXYGEN
to **99.9%** Purity
Capacities to 12,000 cubic feet per hour

Decarburization
Furnace Enrichment
Scarfing
Cutting
Welding

•

Production of synthesis gas for
Ammonia
Acetylene
Methanol, Etc.

NITROGEN
to **99.99%** Purity
Capacities to 36,000 cubic feet per hour

Inert Atmospheres
Annealing
Heat Treating
Furnace Brazing

•

Ammonia Synthesis
Atmosphere Control
Nitrogen for Drug Making
Liquid Nitrogen Scrubbing of Synthesis Gas

Make your own with the

NEW *Air Products* Incorporated
2-in-1 High-Purity **GENERATORS**

DUAL PRODUCTION—*One* Generator makes *both* oxygen and nitrogen at *super high-purities*, ready to be piped to points of use. You save the cost of an extra generator . . . eliminate all transportation costs, down-time due to delivery failures, etc.

NEW VERSATILITY—You can operate the new generators to produce *what* you want *when* you want it: compressed oxygen and nitrogen *simultaneously* . . . compressed oxygen and *low pressure* nitrogen simultaneously . . . compressed oxygen *alone* . . . compressed *or* low pressure nitrogen alone . . . *liquid* oxygen and/or nitrogen.

Find out what this important new development can mean to you. Write, stating your requirements.

AIR PRODUCTS, INCORPORATED
Dept. P, Box 538, Allentown, Pa.

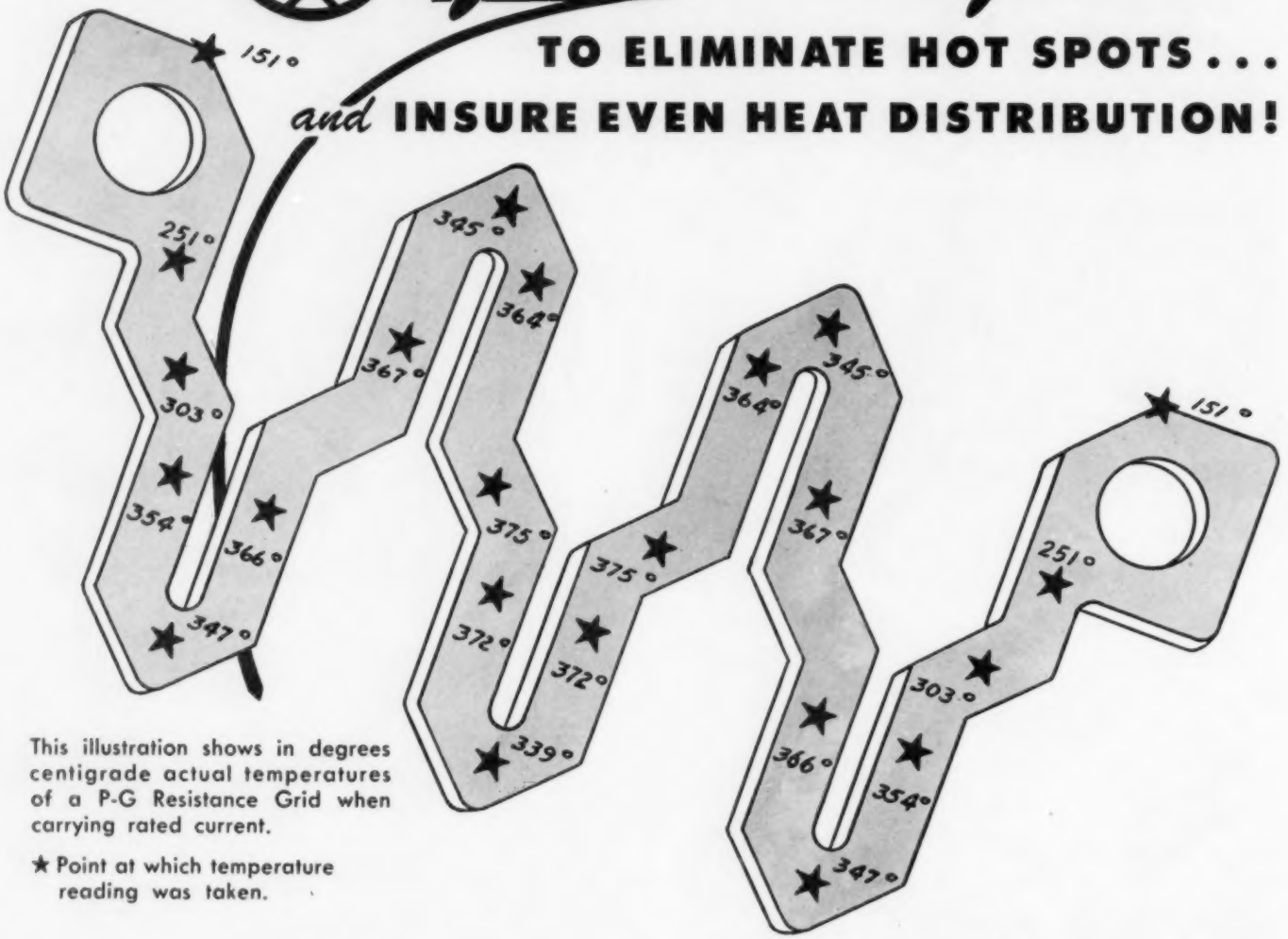
Also *Air Products* Tonnage Generators for OXYGEN-NITROGEN Unlimited!

Produce huge quantities of very low cost oxygen and nitrogen in gaseous or liquid form. Standard models, or specially designed. Cycles according to individual requirements. Generators to produce any quantities, at any purities and pressures. Inquire!

Specialists in Equipment for All Low-Temperature Processes

P-G *Grid Designed*

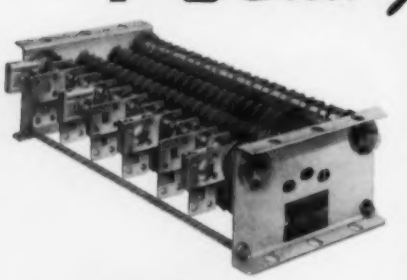
TO ELIMINATE HOT SPOTS . . . *and* INSURE EVEN HEAT DISTRIBUTION!



This illustration shows in degrees centigrade actual temperatures of a P-G Resistance Grid when carrying rated current.

★ Point at which temperature reading was taken.

P-G *Steel Grid Resistors* HAVE DEMONSTRATED THIS FOR MANY YEARS!



Laboratory tests of temperature distribution on "Type T2 Resistance Grids" at rated current indicate extremely uniform temperatures over the entire grid surface. Note also, that temperatures at points of contact are much cooler than at any other point on the entire grid. You, too, can obtain better results by specifying P-G for your next application.

Complete data given in ***NEW*** **BULLETIN No. 500** . . . Copy on request.

The Nonbreakable Steel Grid Resistor

THE POST-GLOVER ELECTRIC COMPANY

• ESTABLISHED 1892 •

221 WEST THIRD STREET, CINCINNATI 2, OHIO

retired. Mr. Duffy had been with Kaiser Steel since 1942, going there from the U. S. Steel Corp.'s Duquesne, Pa., works, Duquesne, Pa., where he had been associated with blast furnace operations since 1918.

James F. McClelland, Jr. has been appointed engineering manager for Rockbestos Products Corp., New Haven, Conn. In his new assignment, Mr. McClelland

JAMES F. McCLELLAND, JR.

will have the responsibility for the coordination and direction of standards engineering, quality engineering, research and development, and chemical engineering. He recently held the position of standards engineer.

Max Lauderback was named metallurgical superintendent at Kaiser Steel Corp., Fontana, Calif. Mr. Lauderback's immediate past affiliation covered more than six years with the U. S. Steel Corp., at Pittsburgh, Pa., where he was assistant metallurgical engineer for the Chicago and Pittsburgh divisions. Previous to that he served for ten years as assistant manager of sheet and strip, metallurgy, for the Chicago Division, headquartering in both Detroit, Mich., and Chicago, Ill.

Richard S. Van Note was named manager of the Chicago, Ill., office of Selas Corp. of America. Mr. Van Note had been associated with Davison Chemical Co. and the C. M. Kemp Manufacturing Co. before joing Selas in 1949. In Chicago he will serve as district sales manager for heat processing and fluid processing equipment.

William H. Meyer has been appointed metallurgical sales engineer for Green River Steel Corp., Owensboro, Ky. **Vincent Burger** was named sales representative. Mr. Meyer was formerly with Brad Foote Gear Works, Hurley Machine Co., and Copperweld Steel Co. Mr. Burger was formerly with Mid-West Material, Inc., Amalgamated Steel Corp., and Peninsular Steel Co.

John V. Eakin was named general manager of Fawick Airflex Division, and **Theodore E. Metz** as advertising manager of the Federal Fawick Corp., Cleveland, Ohio.

Mr. Eakin has been with the company since 1943 and was formerly assistant general manager, sales manager, and southwestern district manager. In his new position, he will be responsible for the direction of Fawick Airflex Division.

Mr. Metz has been the advertising manager of Fawick Airflex Division and of the Fawick Airflex Co. prior to the merger of Fawick and Federal Motor Truck Co., Detroit, Mich. He has been with Fawick since 1948, having previously been a member of the sales department.

Frank W. Nitterhouse, Jr. has been named superintendent of the masonry department of the Middletown, Ohio, division of Armco Steel Corp. Mr. Nitterhouse joined Armco in 1933, and has been in the masonry department since that time.

Paul R. Loughin, who was just named an executive assistant of Babcock & Wilcox Co. has been transferred to the staff of the boiler division in New York, N. Y. Mr. Loughin had been chief engineering for B&W prior to his latest promotion.

George E. Stone has been named to succeed the late **W. W. Patnoe** as chief engineer of Basic Refractories, Inc.

Mr. Stone joined the company's engineering department in May 1921, and has been serving as manager of the firm's Ohio works.

N. George Belury has been elected a vice president of American Brake Shoe Co. Mr. Belury, who continues as president of the Engineered Castings Division, has been with the company since 1937. He served in the sales department of the Brake Shoe and Castings Division before transferring to Engineered Castings sales in 1947.

Ralph E. Campbell has been appointed Pittsburgh, Pa., district field engineer of SKF Industries, Inc. Mr. Campbell joined SKF in 1942 as a steel mill service

RALPH E. CAMPBELL

representative. He has been senior division engineer of the company's steel mill section, at its main plant in Philadelphia, Pa., since 1951.

J. T. Ryan, Jr., was elected president of the Mine Safety Appliances Co., Pittsburgh, Pa. Mr. Ryan suc-

ceeds **George H. Deike, Sr.**, who was named to the post of chairman of the board.

J. E. Kerby, for the past two years manager of Trumbull Electric's southwest district, has been named manager of the newly created west central district, with headquarters in Kansas City. This new district will cover the entire states of Kansas and Colorado, and parts of Oklahoma, Arkansas, Wyoming, New Mexico and Missouri. **A. P. McGraw**, for several years a Trumbull sales representative in the South Carolina area, has been named manager of the southwest district, with offices in Houston, Tex. The southwest district covers all of Texas and parts of New Mexico, Oklahoma, Mississippi, Alabama, Arkansas, Louisiana and Florida. **J. E. Van Effen** has been named manager of the newly established Cleveland district, with headquarters in Columbus, Ohio. Mr. Van Effen was formerly manager of Trumbull's Atlantic district. The Cleveland district will include parts of Ohio, Pennsylvania and West Virginia.

John R. Welsh has been appointed purchasing agent for ferrous scrap for the American Brake Shoe Co. Mr. Welsh is located in the company's headquarters purchasing department in New York, N. Y.

William J. Healy, sales manager of the De Laval turbine division, has been appointed to the additional post of sales manager for the blower and compressor division of De Laval Steam Turbine Co., Trenton, N. J.

Vincent J. Doyle will represent Lebanon Steel Foundry at the newly established Canadian branch office at 304 Crescent Bldg., Montreal, Quebec.

Walter H. Lewis was named as assistant treasurer of Midvale Co., Nicetown, Philadelphia, Pa.

E. G. Fenton, assistant to the president since joining Empire Steel Corp., Mansfield, Ohio in July, 1951, has been appointed works manager.

Francis L. Parrick has been made design engineer for Laclede Arch Co. Mr. Parrick has been assigned to the district sales and engineering office in San Francisco, Calif. He was formerly with the Aluminum Co. of America in their engineering department.

M. Nielson who was recently elected a vice president of Babcock & Wilcox Co. has been placed in full charge of the manufacturing department of the company's boiler division. His new assignment will place him in charge of manufacturing work at the company's seven plants of the boiler division in Barberton and Alliance, Ohio, Wilmington, N. C. (2 plants), Brunswick, Ga., West Point, Miss., and Paris, Tex.

J. F. Wilkes was appointed director of research and product development for Dearborn Chemical Co., Chicago, Ill., in which capacity he will maintain responsibility for the operation and administration of the company's laboratory.

John Brandenburg has been appointed central sales manager of the American Maganese Steel Division of American Brake Shoe Co. Mr. Brandenburg will be located in Chicago Heights, Ill.

Stanley T. Johnson was named purchasing agent, non-ferrous metals for U. S. Steel Corp., Pittsburgh, Pa. Mr. Johnson comes to Pittsburgh from U. S. Steel's Washington, D. C., office. He succeeds **Anthony Siragusa** who died March 15.

Donald L. DeVries was named manager of the precipitator department of the Metal Products Division of Koppers Co., Inc., Baltimore, Md. Since 1950, Mr. DeVries has been serving as a sales engineer in the precipitator department.

Edward L. Cochrane, J. H. King and **Luke E. Sawyer** were elected directors of Babcock and Wilcox Co., New York, N. Y. Present directors who were reelected at the

LUKE E. SAWYER

same meeting were **A. G. Pratt, E. G. Bailey, Alfred Iddles, Paul D. Merica, C. W. Middleton, Stoddard M. Stevens, B. A. Tompkins** and **John C. Traphagen.** Mr. Cochrane, vice admiral USN retired, is dean of engineering at the Massachusetts Institute of Technology. Mr. King is vice president of the company in charge of its boiler division. Mr. Sawyer, also a vice president, is in charge of the company's Tubular Products Division.

A. Velthaus has been appointed resident area supervisor of operation and service in the Pittsburgh area for Research Corp. Mr. Velthaus will be located at 3211 Grant Building, Pittsburgh, Pa.

James V. Burrell was named Michigan district sales representative for Electric Furnace Co. Mr. Burrell has been connected with Electric Furnace Co. for over 15 years in various departments including manufacturing, erection, service and sales. His headquarters are in the company's Detroit, Mich., office, 312 McKerchey Building, 2631 Woodward Ave.

Prof. Clark B. Carpenter, head of the metallurgy department and dean of the graduate school at the Colo-

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5. Forged steel arbor facilitates alignment of cutter and spacer. Diameters are selected to minimize deflection.

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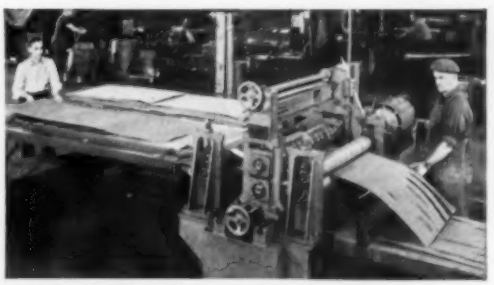

This 36" Bliss slitter makes cuts from 5/8" to 9-7/16" wide. Material thickness varies from 0.014" to 0.045" lamination steel and sheet insulation. Average speed is 150 fpm.

9. Drive motor, completely enclosed, is available for use with either AC or DC current.

10. Arbor bearings are either anti-friction or plain, depending on the requirements.

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It's Bliss

rado School of Mines in Golden, Colo., will retire this summer. Prof. Carpenter will be accorded the rank of professor emeritus after his retirement. He has served on the Mines faculty since 1920, and has been a full professor since 1936.

William E. Ackermann, assistant vice president of Wheeling Steel Corp., vice president of Wheeling Corrugating Co., and president of Ackermann Manufacturing Co., retired on April 1, 1953.

Dr. Harold T. Clark, formerly manager of metallurgical research for Jones and Laughlin Steel Corp., Pittsburgh, Pa., was named to the position of assistant director of research. He will have responsibility for supervision of all divisions of research for J. & L. **George H. Enzian,** formerly assistant manager of metallurgical research, has moved up to manager of metallurgical research.

George W. Bruce has been appointed works manager of the Claymont, Del., plant of the Colorado Fuel and Iron Corp. Mr. Bruce has been associated with the steel

GEORGE W. BRUCE

industry for the past 22 years. Prior to joining Colorado Fuel and Iron, he held positions with Midvale Steel Co. and United States Steel Corp., and with the Steel Co. of Canada, Ltd.

J. E. Brinckerhoff, formerly sales manager of the refractories division of Babcock & Wilcox Co. New York, N. Y., has been named general manager of the division. **C. L. Norton, Jr.,** formerly technical director, will become executive assistant in charge of all development and engineering activities. **Carl Claus,** formerly superintendent of the Augusta works, will become executive assistant in charge of all sales and manufacturing operations. **J. D. McCullough** will continue as chief engineer in charge of engineering, service and application, with additional duties. **Mark J. Terman,** formerly district manager of the Pittsburgh, Pa., office, will become sales manager. **Bradford Hooper,** who had been assistant to Mr. Norton, will become technical director. **Royce K. Mack,** formerly assistant to Mr. Claus, will become superintendent of the Augusta works.

Marsh B. Hall was appointed chief engineer of Acme Steel Co., Chicago, Ill., and **Willard S. Collins** was named assistant chief engineer of the development and research engineering department for the company's Archer Avenue (Chicago) plant. Mr. Hall replaces

MARSH B. HALL

James N. Wognum who was recently named chief engineer of Acme Steel's newly created engineering research laboratory located at 7439 South Ashland Avenue in Chicago. Mr. Collins takes over the duties formerly handled by Mr. Hall.

W. H. Rowand, chief engineer of the boiler division of Babcock & Wilcox Co., New York, N. Y., has been elected a vice president of the company. He will continue to hold the post of divisional chief engineer.

Fred W. Niggemyer has been appointed vice president in charge of sales for Harlan Electrical Construc-

F. W. NIGGEMYER

tion Co., Toledo, Ohio. Before joining Harlan Electrical Construction Co., Mr. Niggemeyer was sales manager for McDowell Co., Cleveland, Ohio.

John J. Holloway, formerly a traveling freight agent with the Santa Fe Railroad, has joined the traffic department of Kaiser Steel Corp., Fontana, Calif., as supervisor, traffic.

Tube Mill Practice

A selection of articles
from the
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on various phases of
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Practical information on layout and operation of facilities for seamless, butt and electric weld pipe, a field in which little information has been published . . . 23 articles by 20 authoritative writers . . . invaluable for engineers, operators, trainees and students.

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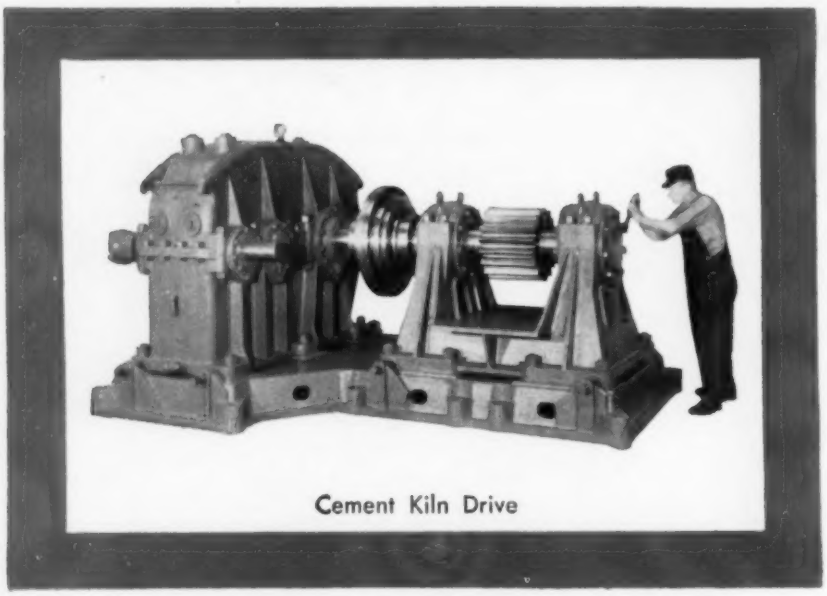

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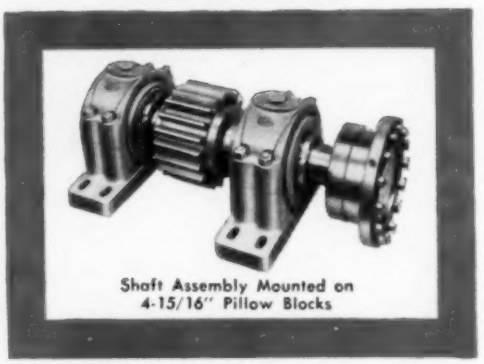

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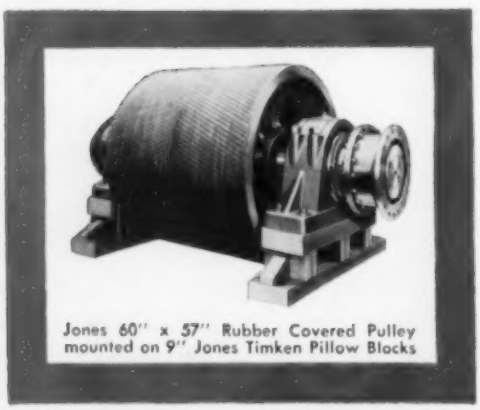

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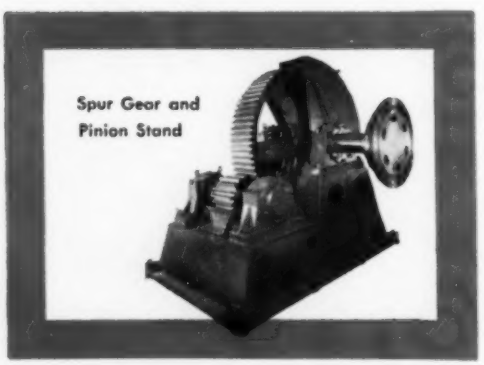

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In The Service Of Industry

Sewell W. Crisman has been appointed to the position of assistant district manager of the Pittsburgh, Pa. office of Elliott Co. Mr. Crisman has been serving as a field engineer for the Pittsburgh office of Elliott Co.

Dr. Walter R. Hibbard, Jr., has been appointed manager of the newly established alloy studies section in the General Electric research laboratory's metallurgy research department, Schenectady, N. Y.

Paul L. McCullough, Jr. has been appointed sales manager of the Electro-Alloys Division of the American Brake Shoe Co. Mr. McCullough has been serving as district sales manager for the Amsco division in Pittsburgh, Pa., since 1951.

James A. Gramling was made manager of the newly opened Milwaukee, Wisc., office of Ehret and Kinsey, representatives of the American Flexible Coupling Co., Erie, Pa.

Mathias E. Szeyller was named engineer for the A. J. Gates Co., Baker-Rauling Co. representatives in northern Ohio. Before joining the Gates staff, Szeyller was associated with the Electric Storage Battery Co.

C. P. Cryer has been appointed representative for the eastern territory by the Lintern Corp. of Painesville, Ohio. Mr. Cryer will represent Lintern in Eastern Pennsylvania, New Jersey, Delaware and Maryland.

Joseph L. Walker has joined Heyl & Patterson, Inc., Pittsburgh, Pa., as contracting engineer. His duties at Heyl & Patterson will be the sales and service of the American line of Reineveld centrifuges and separators.

Samuel P. Felix has been appointed general manager of the De Laval Turbine Pacific Co. De Laval Turbine Pacific Co. is a wholly owned subsidiary with main offices and plant located in San Francisco, Calif., and district offices in Los Angeles, Calif., and Seattle, Wash.

Samuel S. Board, Jr. was named director of research at the Buffalo, N. Y., plant of Farrel-Birmingham Co.,

SAMUEL S. BOARD, JR.

Inc. Mr. Board has been serving as assistant director of research, since 1947.

W. A. Holt has been appointed manager, furnace division, Gas Machinery Co. (Canada) Ltd., Hamilton, Ontario, the subsidiary of Gas Machinery Co. in Cleveland, Ohio. Mr. Holt was previously associated with Salem Engineering (Canada) Ltd. and Atlas Steels, Ltd., in Welland.

Obituaries

Frank Purnell, 66, chairman of the board of Youngstown Sheet & Tube Co., Youngstown, Ohio, died April

FRANK PURNELL

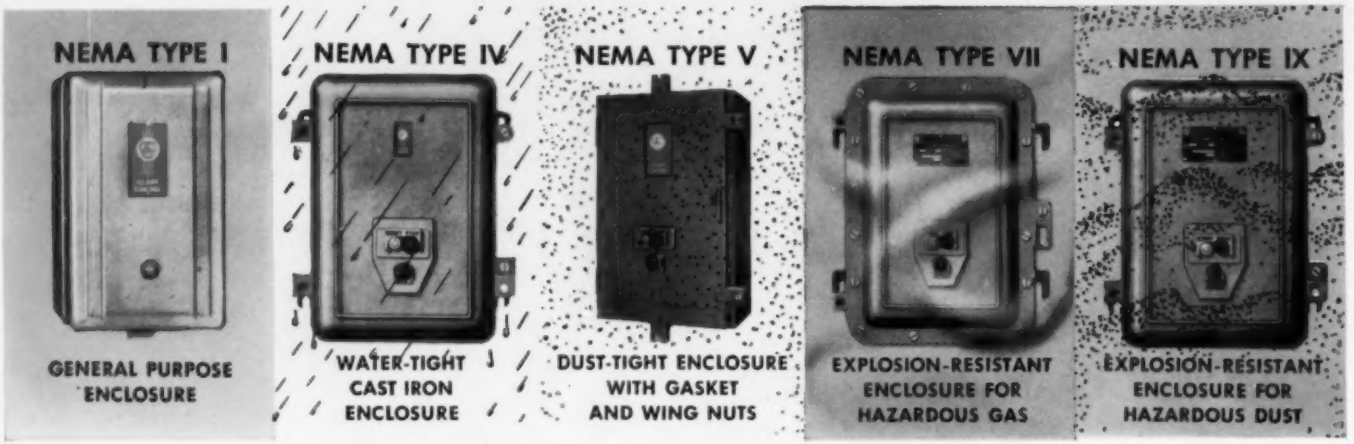
19. He relinquished the presidency of the company in 1950, a position he had held for 20 years.

Gano Dunn, 82, died April 10 in New York, N. Y. Mr. Dunn, who had been president of the J. G. White Engineering Council for 40 years, was an honorary member of the Association of Iron and Steel Engineers. At the first cooperative safety congress held in Milwaukee, Wisc., September 30—October 5, 1912, during the annual AISE convention, Mr. Dunn wrote the famous resolution instructing the AISE to take the first steps toward the formation of a national organization for the promotion of safety to human life. As a result of this meeting and Mr. Dunn's resolution, the National Safety Council was created.

W. W. Collins, superintendent of mechanical maintenance and master mechanic of the Sand Springs, Okla., Division of Sheffield Steel Corp. for 15 years, died March 22.

William C. Royal, 48, Cleveland, Ohio, representative of Selas Corp. of America, died April 9.

Joseph B. Petty, 39, director of labor relations at the Fontana, Calif., works of Kaiser Steel Corp., died, April 20.



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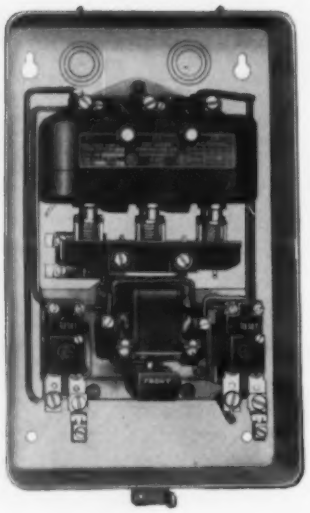
use CLARK TYPE "CY" STARTERS



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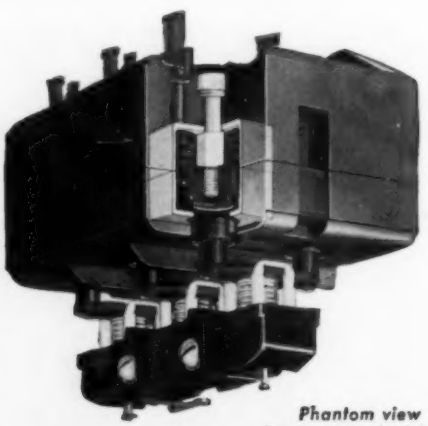
The incomparable new multi-turn magnetic blowouts combined with twin-break contacts, and the rest of the operating mechanism, are enclosed in types of cabinets to protect against adverse conditions or dangerous atmospheres.

Type "CY" starters, Sizes 2 and 3, employ an entirely new principle of arc interruption. The arc is extinguished by the effect of the blowout coil, concentric with the contact. The magnetic field quenches the arc either by lengthening or confining it. In its forced rotation it moves continually from a hot to a cold spot—minimizing burning or pitting of contacts. The ingenious design of the arc chamber prevents carbonization and the accumulation of hot gases between wiring terminals—minimizing phase-to-phase failures. Sizes 0 and 1 use the same general mill type construction as the larger sizes.

- **No filing, dressing or cleaning of contacts!**
- **No tools necessary to inspect contacts!**
- **Easy to change moving contacts!**
- **Stationary contacts changed quickly!**
- **Remove only two screws and one pin to change coils!**
- **Remove only four screws to take out stationary magnet frame!**
- **Power circuit contacts available with springs in complete packaged service kits for ease in stocking!**



Phantom view showing Arc-shield

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(1) Valves

A comprehensive catalog entitled "Valves for the Process Industries" is available to you. The 50-page book contains complete information on manual, electric, and hydraulic valves. The following types are discussed: gate valves, control valves, angle valves, butterfly valves, reversing valves, hot gas valves, check valves, and valves for special applications. Tables and curves are included to help the valve user determine requirements. (A-205). Gas Machinery Co.

(2) Industrial Heaters

A 32-page catalog is available that gives the complete story on standard and heavy-duty centrifugal fan industrial heaters. Standard industrial heaters are used to heat large areas where conventional heating equipment is inadequate. Heavy-duty industrial heaters are particularly suited for use in steel mills. They are used with high-pressure steam systems and have a wrought iron construction. Information on where to use the heaters, at what circulating capacities and temperatures, and how to place them is given in an application section. Another section explains automatic temperature control and tells how to estimate the heat load a particular heater must carry. As an aid to selection, a set of typical specifications is given and typical examples are worked out. Also towards this aim, tables and graphs of performance data are given as well as outline dimensions of the units. Other sections cover construction features, accessories, and instructions for installation. (1510). Sturtevant Division, Westinghouse Electric Corp.

(3) Shovel Loader

New literature describing the construction and industrial uses of the "Baker-Lull Shoveloader" has been issued. The literature illustrates applications and attachments for the front end loader, lists specifications of the equipment and describes performance characteristics. Baker-Lull Manufacturing Co.

(4) Electronic Air Cleaners

An application study is available describing electronic air cleaners in the steel mill power house control room at Weirton Steel Co., Weirton, W. Va. The study will be of help to those who are interested in providing completely clean air in similar locations. (AS-106). Trion, Inc.

(5) Continuous, Atomic Weighing Scales

A new bulletin covering the complete "Transportometer" line of continuous, automatic weighing scales is available. The "Transportometer" line is used for accurate, precise control of production input and output by automatic, continuous weighing, in transit, of raw, intermediate and finished materials and products. It consists of three basic models designed to meet any continuous weighing and feed regulating requirements: "Transportometer" — for installation on new or existing belt conveyor; "Transportoweigher" — complete weighing and conveying unit; and, "Transportofeeder" — complete feed regulating, weighing and conveying unit. The line of automatic, continuous weighing scales employs the only true weight integrator, and unlike other types of continuous weighing equipment, contains no inherent error in its design. (301). Sintering Machinery Corp.

(6) Industrial Controls

A catalog is available that describes and illustrates non-indicating electric, electronic and pneumatic controllers for temperature, pressure and humidity, also pneumatic and electric valves, switches and relays. Included are specifications, dimension drawings, application data and ordering information. (8305). Industrial Division, Minneapolis-Honeywell Regulator Co.

(7) Distribution Panelboards

Just issued is a new booklet describing the "Noark Flexunit" plug-in distribution panelboard. Besides listing specifications and enclosure sizes, the catalog describes in detail exclusive features of the unit. This distribution panelboard is available for 30, 60, 100, and 200 ampere 250 volt operation with 2 and 3 pole branches; and for 30, 60, and 100 ampere, 575 volt operation with 2 and 3 pole branches. These distribution panelboards can be assembled on-the-job from stock parts in a matter of minutes; circuits may be changed or added to the panelboard with a minimum of lost time. Exclusive features include "Noark" plug-in stabs, successfully used for years in other of the company's electrical devices. Five standardized chassis and surface cabinets are available, offering a broad range of possible combinations of electrical circuits. Suggestions on correct installation, including a step-by-step photographic demonstration of an assembly, are included in the leaflet. Federal Electric Products Co.

(8) Shipping of Fire Brick

A manual on "Recommended Equipment and Procedure for the Palletized Loading and Shipment of Refractory Brick" has just been released. This manual, containing 28 pages of scale drawings and descriptive material, covers: the standard wooden pallet, standard pallet load protection, carloading patterns, and standard wooden end and side gates. It fills a long felt need in the refractories industry for a uniform recommended palletizing procedure and should prove to be a boon to both manufacturer and consumer alike. A special committee of The Institute has studied all aspects of this problem for over a year. A wide variety of palletizing practices were examined and the advantages and disadvantages

of each were carefully analyzed. Consumer and transportation associations were consulted. The manual now offered represents a detailed formula for the palletized handling of refractories which can be followed readily by all shippers. The Refractories Institute.

(9) Lorain Cranes

Just produced is a 12-page picture book showing the varied applications of the Lorain crane line on docks, barges and ships. Pictures and short job descriptions make the book interesting and easy to read. Thew Shovel Co.

(10) Inductance Bridge Receiver

A special bulletin is available that describes and gives specifications on new addition to manufacturer's line of "ElectroniK" instruments. Called the inductance bridge receiver, the instrument combines numerous functions such as integration, recording, control, retransmission, remote index setting in one instrument case. Brief descriptions of various ways in which instrument can be used are included in bulletin as are specific applications in the steel, metals treating, and power industries. (1540). Minneapolis-Honeywell Regulator Co., Industrial Division.

(11) Desk Calculator

A six-page, pocket size folder entitled "Desk Calculator," is available to you. The calculator presents in easy-to-use form, formulas, constants and conversion factors useful in basic engineering, blast cleaning and dust control calculations. Included are geometric relationships for circles, squares, cylinders, spheres, pyramids, cones, trapezoids, etc.; measures of pressure; and calculation guides for determining tank capacities in gallons. Other major categories of basic information include formulas for dust control work, tables on shot and grit sizes, and metric measurements and conversion factors. The dust control section gives symbols and relationships of pipe area to air volume, air volume to air velocity, air velocity to velocity pressure and velocity pressure to friction loss. In addition, facts on centrifugal fans and exhausters with regard to variations of volume, pressure and horsepower with speed are presented. Pangborn Corp.

(12) Starter Selection

Tips on selecting the right starter for squirrel-cage induction motors rated up to 600 hp at 600 volts or less are contained in a new bulletin just released. Information included in the bulletin tells how to select the proper type starter, enclosure and operating arrangement, and explains how to determine whether a full or reduced voltage starter should be used. An explanation of two or three-wire control and hints on the selection of heater elements for overload relays are also given in the bulletin along with a cage starter selection chart. (14B7733). Allis-Chalmers Manufacturing Co.

(13) Recording Potentiometers

Three new specification sheets describe and illustrate "Brown ElectroniK" recording potentiometers. Specification Sheet 160 covers circular chart recorders; Specification sheets 164 and 165 cover single and multiple record strip chart recorders. Construction and engineering details are included. Minneapolis-Honeywell Regulator Co., Industrial Division.

(14) Pressure Transmitters

A new bulletin has been published on pressure primary element transmitters for use with "Swartwout Autronic" controlling and recording system. The bulletin describes the Type P2T pressure transmitters in detail and gives data on principles of operation. It is illustrated with schematic diagrams, phantom views, dimensional drawings, etc. Technical data such as pressure ranges and span are also included. (A-708). Swartwout Co.

(15) Steel Castings Manual

Comprehensive data detailing applications emphasizing the reliability, strength, and versatility of steel castings as an engineering material widely used in more than 100 vital industries is being made available in booklet form by Steel Founders' Society of America. Reprinted in manual format, the 16-page illustrated booklet "Carbon and Low Alloy Steel Castings," incorporates much essential data of value to the materials engineer, design and production engineering organizations, purchasing departments, engineering students and university faculty members, and others active in design and processing and specifications categories. Included is definitive material covering steel casting properties, specifications, design, joining, heat treating, and inspection procedures. Of especial value is a two-page chart devoted to general engineering types of steel castings, classified according to tensile strengths. Steel Founders' Society of America.

(16) Pipe Line Filters

A new bulletin describing four new low pressure pipe line filter models has been announced. The bulletin contains specifications, engineering and performance data covering this new type filter recommended for the removal of dust, dirt, pipe scale, condensed oil and water vapor from compressed air lines. One bolt construction permits media cleaning without breaking any pipe line connections. (210). Dollinger Corp.

(17) Stainless Steel Electrodes

Just released is a 20-page catalog on a complete line of "Arcaloy" stainless steel electrodes. The catalog includes explanation of the two basic types offered — Lime coating for all-position welding with d-c reverse polarity, and a-c/d-c for welding of chrome-nickel steels with all types of a-c or d-c welding equipment — individual descriptions of the 23 regular analyses and special analyses of these electrodes, weld metal properties, welding procedures, electrode analysis and color charts, current ranges, and AISI type numbers. (AR53-16). Alloy Rods Co.

(18) Non-Ferrous Castings

The second edition of a catalog entitled: "Stoody Castings" is available. This book describes these non-ferrous castings which are made of hard metal alloys, for use in varied industrial applications where abrasive wear is a major factor and conventional castings are inadequate. The castings can be used for steel mill guides and side rolls operating at high temperature with or without lubrication and subject to extreme abrasion. Other uses are: for tin mill bushings which run without lubrication in a corrosive medium, bearings and bushings of many kinds subjected to destructive wear, forming rolls operating under tremendous pressures, ball valve seats, and journals and sleeves which may frequently have to operate without lubrication. The supply of this catalog is limited, so only requests from users of castings can be considered. Stoody Co.

(19) Sectional Cascade Coolers

Publication is announced of a catalog section covering the newly designed "Karbate" brand impervious graphite sectional cascade coolers, Series "CC." The new design of the popular "Karbate" sectional cascade coolers is fully described and their applications outlined. The three standard

sizes are illustrated by dimensioned engineering drawings, and the features, common to all sizes, are explained: Type SN armored connections; radiused cross-overs between sections for high fluid velocities with minimum pressure drop; high cooling water capacity; redwood water guide strips with stainless steel clip springs; heavy base plate castings; and "Teflon" gaskets that eliminate gasket replacement and maintenance. The section also contains information to aid in the selection of impervious graphite sectional cascade coolers for the cooling of corrosive liquids and gases, complete tables of dimensions and specifications, as well as nomographs for determining cooling water requirements, overall heat transfer coefficients, and required cooling surface. (S-6820). National Carbon Co.

(20) Graphite Combustion Chambers

A new catalog section has been announced covering "National" graphite combustion chambers with "Karbate" brand impervious graphite burner nozzles. This complete processing unit is fully illustrated and described, with detailed suggestions and recommendations for its use in the burning of wet hydrogen and chlorine gases from diaphragm cells; in the burning of "sniff gas" with wet or dry hydrogen; or in the burning of re-evaporated chlorine, dried but not compressed chlorine, or cooled but not dried chlorine from mercury cells with wet or dry hydrogen. Dimensioned engineering drawings show the construction of the combustion chambers and burner nozzles. Tables of dimensional sizes and capacities are a handy reference for specifying, ordering, installing and operating the equipment. The principal features emphasized in the catalog are the equipment's immunity to hot (uncooled) cell gases saturated with water, its long life without corrosion and with a minimum of maintenance, its ability to withstand thermal shock, its ultra-simple design which permits the construction of acid systems which have no moving parts, and its moderate installed cost. (S-7530). National Carbon Co.

(21) Heavy Presses

Problems involved in the design and construction of Bliss' 35,000 and 25,000-ton presses for the Air Force heavy press program are described and illustrated in a 12-page special issue of the Bliss "Newsletter." Features of the giant presses such as the underdrive construction, combination weldment-casting design, welding methods, tie-rod assembly and hydraulic system are described in detail. Included in this issue is a report on the planned use of the presses by the manager of a heavy forging press plant. E. W. Bliss Co.

(22) Flexible Couplings

A revised catalog is available describing "L-R" flexible couplings, "Lovejoy-Ideal" variable speed transmissions, and "Lovejoy-Dix" universal joints. The catalog contains selection tables, dimensions, and price lists, as well as complete data on the various products of this company. (521). Lovejoy Flexible Coupling Co.

(23) Metal-Working Machinery

A booklet is available that pictorially, with brief descriptive matter, presents various cold-process metal-working machinery which is representative of the mechanical equipment manufactured by this company. It is not intended to serve as a catalog, although pamphlets and catalogs on specific equipment can be obtained by requesting after you have studied the data in this booklet. (IS-453). Waterbury Farrel Foundry and Machine Co.

(24) Rail Catalog

To serve every type of industry that uses trackage, a new catalog, titled "Rails," has been issued. Illustrations of rail sections in the catalog are in profile complete with design dimensions all in actual size for use in comparison with actual and sections samples, or for use with tracing drawings. Angle and splice bars are illustrated on each section from 12 lb to 155 lb inclusive, and on crane rail sections from 104 lb to 175 lb. Handy specification tables are shown with each diagram.

For angle bars and splice bars, the catalog includes ordering and punching information and specifications with full size, dimensioned diagram of each rail section.

For rails, drilling and ordering information is included. Specifications for rails are accompanied by full-size, dimensioned diagrams and conversion tables for 12 lb through 175 lb sections. (575). L. B. Foster Co.

(25) Spear Flame Burners

A new bulletin is available that describes the Selas spear flame burner in the five sizes manufactured. Of special interest are the full size illustrations of the burners and the flame length produced by them, together with Btu capacity, port area and full dimensions. (SC-1001). Selas Corp. of America.

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52	AMERICAN FLEXIBLE COUPLING CO.	CATALOG 501	Amerigear couplings with the fully crowned teeth.
53	AMERICAN MANGANESE STEEL DIVISION, AMERICAN BRAKE SHOE CO.		Illustrated catalog on Amscoating.
54	AMERICAN WHEELABRATOR & EQUIPMENT CORP.	BULLETIN 894	How to descale steel strip at high speeds and low cost.
55	BLISS CO., E. W.	BULLETIN 44	Bliss slitters.
56	BROWNING AND CO., INC., VICTOR R.	BULLETIN "E"	Browning mill type cranes.
57	CONE-DRIVE GEARS DIVISION, MICHIGAN TOOL CO.	BULLETIN CD-173	Cone-Drive gears at work in industry.
58	DURABLA MANUFACTURING CO.	BULLETIN IS-5	Durabla pump valve units.
59	ELECTRIC CONTROLLER & MFG. CO.	BULLETIN 921-6.0	Dynamic braking bridge-stop control.
60	ELECTRIC SERVICE MANUFACTURING CO.		Bulletin on Keystone glastic insulators.
61	FARNCO SALES CO.		Illustrated literature on Farnco conveyor.
62	FARVAL CORP.	BULLETIN 25	Farval lubricating systems.
63	FULLER CO.	BULLETIN C-6	Fuller rotary compressors.
64	GENERAL ELECTRIC CO.	BULLETIN GET-1789A	G-E drive engineering at work.
65	HEIL PROCESS EQUIPMENT CORP.	BULLETIN 43-A	Heil steam jet agitators.
66	HOMESTEAD VALVE MANUFACTURING CO.	BOOK NO. 39	Valve reference book.
67	IDEAL INDUSTRIES, INC.		39-page handbook on commutator maintenance.
68	INDUSTRIAL GEAR MFG. CO.	BULLETIN 152-A	A Pictorial Trip Through Industrial.
69	JOY MANUFACTURING CO.	BULLETIN MC108	Joy electrical connectors.
70	KAISER ALUMINUM & CHEMICAL SALES, INC.		Bulletin gives advantages of Permanente 165 and Permanente 84.
71	KOPPERS CO., INC., FAST'S COUPLING DEPT.		Catalog giving detailed descriptions, engineering drawings, capacity tables and photographs.
72	LEEDS AND NORTHRUP CO.	FOLDER N-33-640	"Measure Bath Temperatures Effectively."
73	LINTERN CORP.	BULLETIN AC-533	Lintern aire-rectifiers.
74	MINNEAPOLIS-HONEYWELL REGULATOR CO., INDUSTRIAL DIVISION	CATALOG 1530	Electronik controllers.
75	MOHR & SONS, JOHN		Illustrated bulletin on the Mohr revolving distributor.
76	OHIO ELECTRIC MFG. CO.	BULLETIN 112	Ohio magnets.
77	PITTSBURGH LECTROMELT FURNACE CORP.	CATALOG 8	Lectromelt furnaces.
78	POOLE FOUNDRY AND MACHINE CO.		Catalog on flexible couplings.
79	POST-GLOVER ELECTRIC CO.	BULLETIN 500	P-G steel grid resistors.
80	POST-GLOVER ELECTRIC CO.	BULLETIN 410	P-G master switches.
81	R&IE EQUIPMENT DIVISION, I-T-E CIRCUIT BREAKER CO.	BULLETIN 1725	R&IE Kirk Key interlocks.
82	SQUARE D CO.	BULLETINS 9003 AND 7950	Master switches and mill control.
83	TAYLOR CHAIN CO., S. G.		Catalog available on alloy steel chain.
84	TRABON ENGINEERING CORP.	BULLETIN 515	Trabon spra-lube system.
85	UNITED STATES GRAPHITE CO.		40-page catalog on USG brushes.
86	WAGNER ELECTRIC CORP.	BULLETIN MU-185	Wagner electric motors.
87	WELLMAN ENGINEERING CO., ANKER-HOLTH DIVISION		Bulletin on Anker-Holth products.
88	WESTINGHOUSE ELECTRIC CORP.	BOOKLET B-4730	Westinghouse mill motors.

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1000 heats without a hole...

WITH PERMANENTE 165!

From one of the country's largest steel mills comes this report:

"The Permanente 165 bottom in #19 open hearth furnace producing low-carbon steel is now two years old, has produced 225,000 tons in 1000 heats, and has never had a hole!"

It's another example of the superior performance possible with a Permanente 165 bottom. The odds are that this proved superiority can greatly increase production for *you*.

Among the *20 quality advantages* of Permanente 165 are: high MgO *periclase* derived from high-purity sea water magnesia, and great volume stability because the periclase grains are pre-shrunk and accurately sized.

SEND FOR BOOKLET giving *all* the important advantages of Permanente 165 and the companion material, Permanente 84. Upon request, your Kaiser refractory engineer will promptly offer you research, design and installation service to help you obtain more steel tonnage per year, at lower bottom cost per ton. Call or write principal sales offices: *Chemical Division*, Kaiser Aluminum & Chemical Sales, Inc., 1924 Broadway, Oakland 12, California. First National Tower, Akron 8, Ohio.

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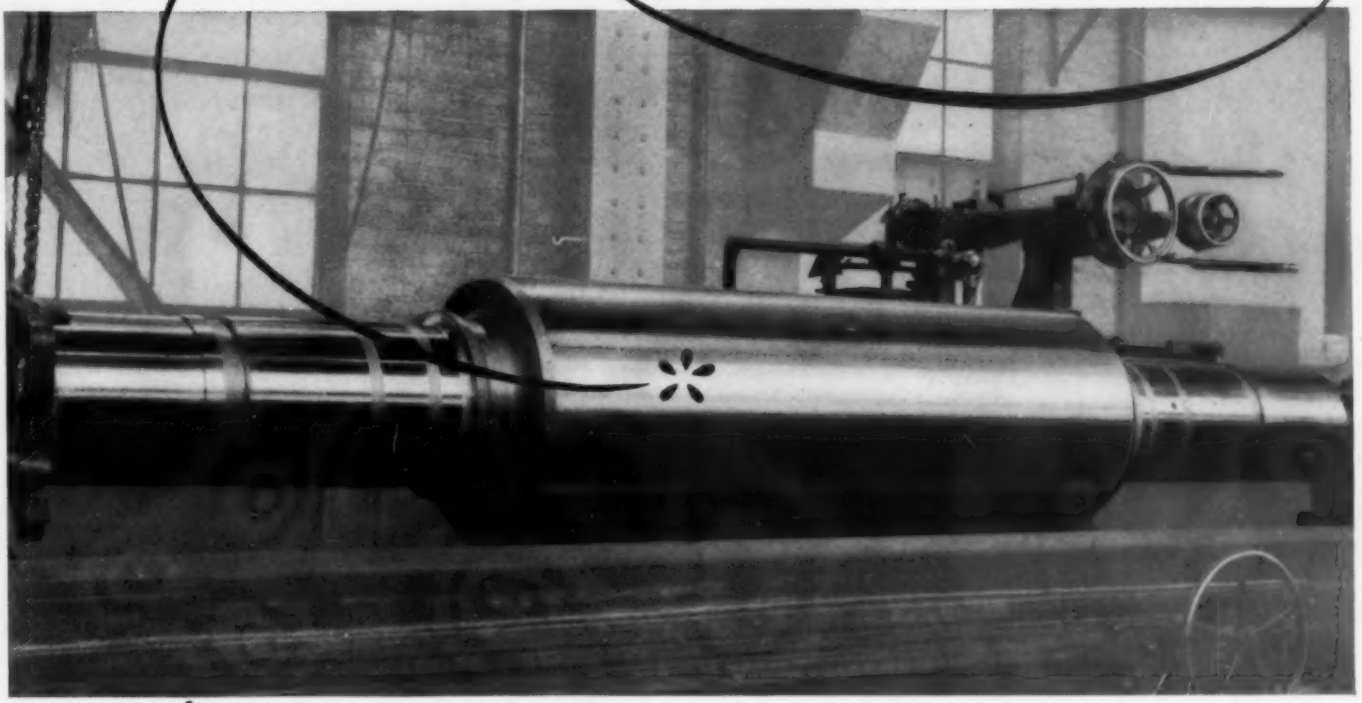

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. . . designed and built with your requirements in mind!

When you specify Birdsboro Rolls, you get rolls made to fit your specific needs. That is why Birdsboro Rolls have such an outstanding reputation for giving longer roll life, greater tonnages, and more rolling accuracy. Get in touch with Birdsboro if you want individually designed, *highly specialized* "copper bearing" alloy steel and alloy iron rolls.

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BIRDSBORO STEEL FOUNDRY & MACHINE CO., BIRDSBORO, PENNA. ROLLS Offices in Birdsboro, Pa. and Pittsburgh, Pa.

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Some furnaces need heat input that varies like this—

Electr-O-Line

PROPORTIONAL CONTROL

is the type to choose for these furnaces. It varies fuel flow by throttling a motor-driven valve in exact response to changes in heat demand. Both proportional and reset actions are provided: proportional control to change fuel flow in relation to the size of the temperature variation; and reset action to correct for sustained changes in furnace load, fuel supply pressure, Btu value of fuel.

Some furnaces need heat input that varies like this—

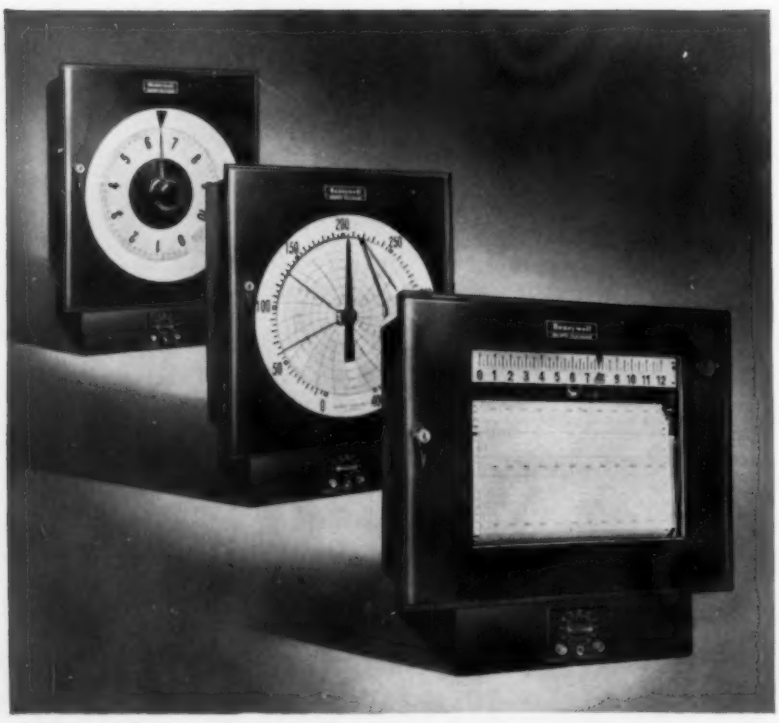
Electr-O-Pulse

PROPORTIONAL CONTROL

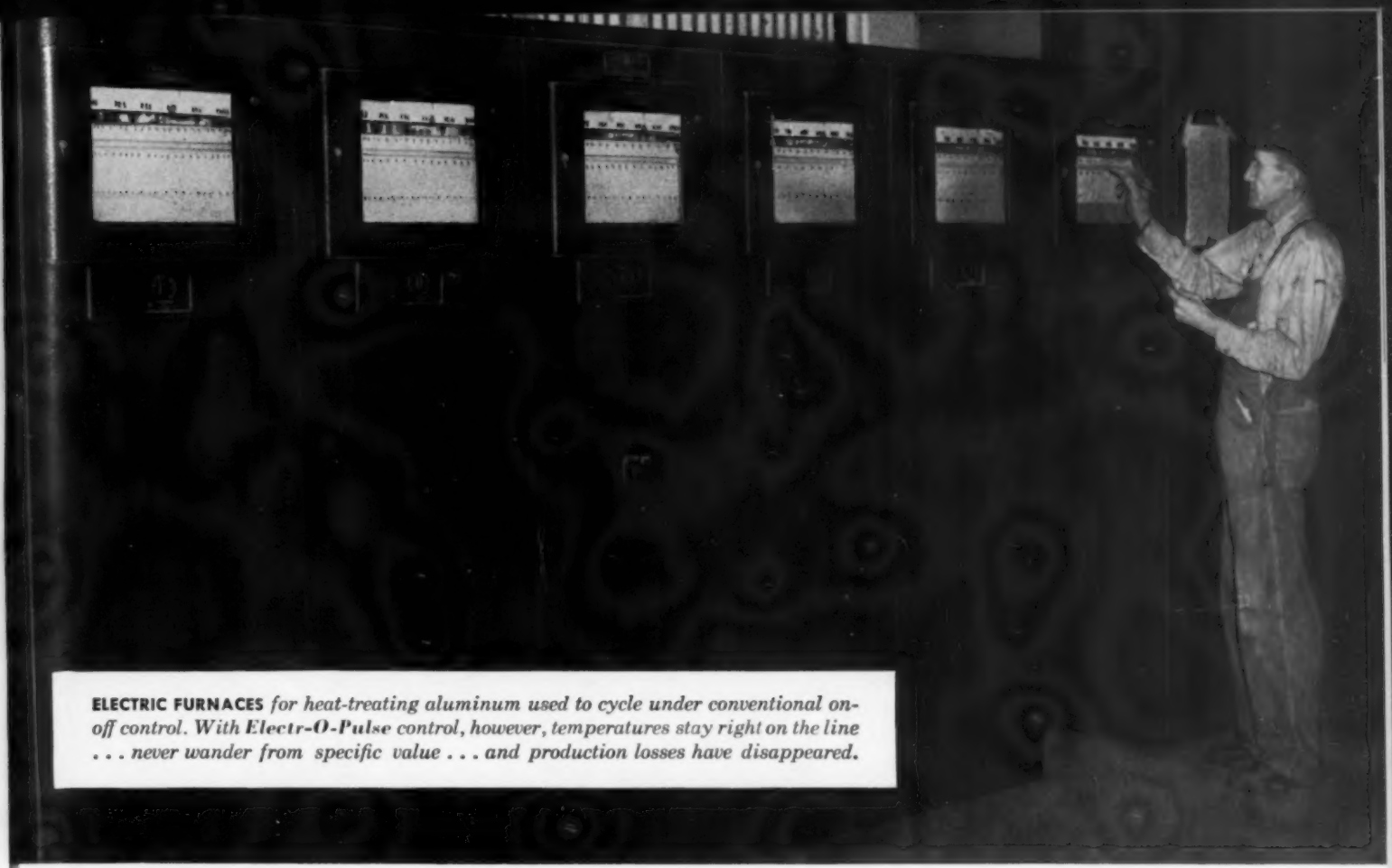
supplies time-proportioning control for electric furnaces and for certain types of fuel-fired furnaces that require this action. It delivers full heat in pulses, controlling the ratio of "heat on" to "heat off" time to regulate average input to balance heat demand. *Electr-O-Pulse* has both proportional and reset actions—regulates a power contactor for electric furnaces, a solenoid or motor-driven valve for fuel-fired units.

Where requirements are less critical, choose Manual Reset Control. It provides the same position-proportioning action as ***Electr-O-Line*** *Control, but reset is manually operated.*

Choose the Honeywell that fits



Any of these ***ElectroniK*** *models can be supplied with* ***Electr-O-Line****,* ***Electr-O-Pulse*** *or Manual Reset Control relay, mounted integrally below the instrument.*



ELECTRIC FURNACES *for heat-treating aluminum used to cycle under conventional on-off control. With Electr-O-Pulse control, however, temperatures stay right on the line . . . never wander from specific value . . . and production losses have disappeared.*

electric control *your* furnace best!

YOUR FURNACE will do its best work when it's regulated by the Honeywell electric proportioning control that suits its own requirements most exactly. These systems keep any furnace "on temperature" with precision that spells real profits . . . in lower rejects, greater output, and uniform high quality work. And you gain these further advantages:

1. ***Space saving:*** control relay is an integral part of the control instrument . . . needs little panel space.
2. ***Easy "tuning"*** to your own furnace. Proportional and reset adjustments are entirely independent—do not interact with each other.
3. ***Plug-in design:*** the entire relay is a plug-in unit, replaceable in seconds.

Any *ElectroniK* strip chart, circular chart or circular scale instrument can be supplied, complete with any of the electric control types listed on the opposite page. For modernizing existing installations, the control relays are available separately.

Your local Honeywell engineering representative is well qualified to recommend the type of control best suited to your furnace. Call him in today . . . he is as near as your phone.

MINNEAPOLIS-HONEYWELL REGULATOR CO., *Industrial Division*, 4464 Wayne Ave., Philadelphia 44, Pa.

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SPRA-LUBE SYSTEM

The answer to flexible, easy application of oil or grease to open gears, slides, etc. Sprays measured volume of lubricant while machine is operating under full load.

The Trabon Spra-Lube Valve is a simple device in which the flow of lubricant through the valve is used to open an air valve. Air and lubricant, either oil or grease, are then piped to a mixing nozzle and sprayed on the open surface. Accurate control eliminates waste and mess.

Both the Trabon Spra-Lube Valve and the nozzle can be mounted where convenient and supply lines run in the most protected manner.

Sealed . . . rugged . . . simple . . . positive.

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Oil and Grease Systems

Equipment News...

VARIABLE-SPEED DRIVE

▲ Designed to economically meet steadily increased needs for adjustable speeds in the lower horsepower ranges in the machine tool and metalworking industries, an improved, all-electric adjustable-speed drive of from ¾ to 3-hp is announced by Reliance Electric & Engineering Co.

The new electronic-type variable-speed drive, called the "V*S, Jr.," is designed to take care of the growing number of production operations in machine tool and metalworking plants having these relatively low horsepower requirements.

First introduced in 1950 as a smaller, lower-cost version of the packaged Reliance "V*S" drive, the new "junior" unit incorporates several design refinements. It is also now available in five sizes — ¾, 1, 1½, 2, and 3-hp ratings.

The new variable-speed drive, providing stepless adjustable speeds from a-c circuits in the range of ¾ to 3-hp, is therefore said to supply a cost-saving answer electrically to the problem of securing greater speed-changing flexibility, application versatility, and control convenience in the operation of a wide variety of machine tools and metalworking production units.

Applications to date already indicate that it broadens the opportunities of many manufacturers as well as original equipment makers to increase output, trim costs and improve product quality.

Readily adaptable for application to existing machines or for installation as an in-built, integral unit as original equipment, the space-saving drive is ideally suited for powering many different types of machines — such as fractional high-speed drills and rotary and cylindrical grinders.

Other applications include chain, apron, belt and screw-feed conveyors; small test stands; welding tables, welding head positioners; press table feeds, and such wire-manufacturing equipment as looms, drawing stands, enameling and annealing furnaces, electrolytic plating baths, spring-forming units, and wire-forming machines.

The new variable-speed drive is based upon the same variable-voltage control principles used by the manufacturer 15 years ago in pioneering its variable-speed drive — the original all-electric packaged drive — in the larger horsepower sizes. A constant torque variable-horsepower drive, the new unit operates at speeds of from 270 to 2300-rpm, and as low as 75-rpm for setting-up operations, light loads or intermittent duty. Its components

are a drive motor, the operator's control station, and the control unit.

The drive unit is the Reliance heavy-duty type T motor, designed specifically for adjustable-speed service, available in ratings of ¾, 1, 1½, 2, and 3-hp. The operator's control station, housed in a compact, conventional (NEMA No. 1) enclosure, provides "Start-stop" buttons, a "jog-run" selector switch, and a speed adjuster.

The control unit, mounted in a compact steel cabinet, requires no attention from the machine operator; it may be located on a wall or column in the plant area where it is to be used, in the base of the driven machine, or in a remote location. All three components may be closely associated or widely separated as optimum equipment efficiency may dictate.

Operating from a plant's incoming a-c power supply, the Reliance V*S, Jr., provides a number of notable operating features. Among the more important ones are: direct application of power to equipment; conveniently centralized control; smooth stepless starting; controlled acceleration; wide speed range; stepless adjustable speeds; unlimited speed changes; jogging, inching, creeping; speed setting before starting; quick, smooth stopping, and fast, smooth reversing.

To meet requirements posed by special equipment applications or processing conditions, the drive motor is also available with all types of enclosures and mountings. In addition, certain optional equipment and accessories may be obtained. These include three types of control stations: (1) foot-pedal operated, for starting, stopping and speed control; (2) explosion-proof, for use in hazardous atmospheres; and (3) reversing drum-switch, which provides forward and reverse functions with speed control.

CLUTCH UNIT

▲ The Fawick Airflex Division of Federal Fawick Corp. announce a new air-operated industrial clutch, the new Fawick "Type VC" air-ring

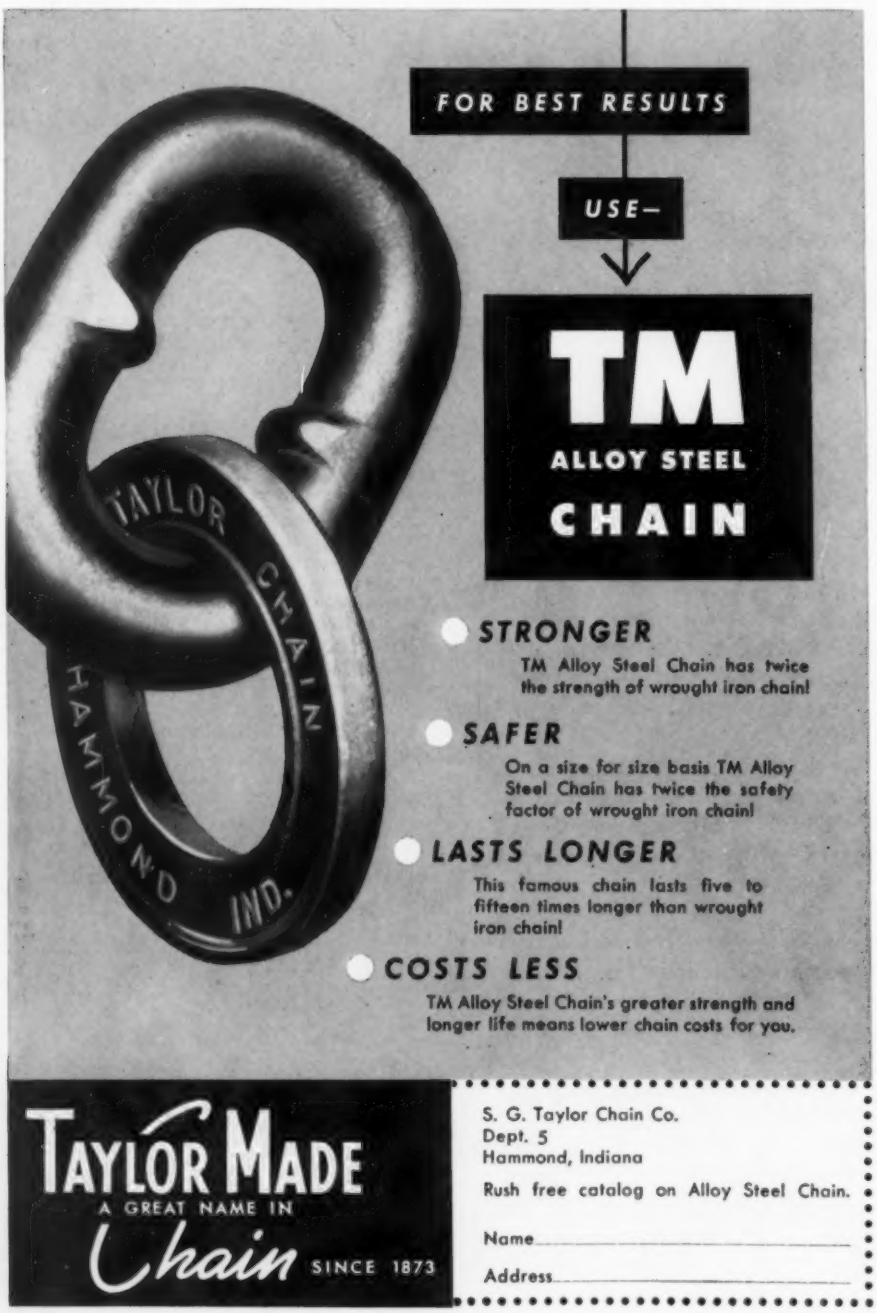
OPEN HEARTH LADLE

The first of 18 open hearth ladles of 265-ton capacity — among the steel industry's largest — is being constructed at the Bethlehem, Pa., plant of Bethlehem Steel Co. The steel ladles, more than 16 ft high and weighing 44 tons apiece, will be installed at the company's Sparrows Point, Md., plant as part of an expansion program. The ladles are being stress-relieved after welding. In shipping, the riveted band four feet above the bottom will be removed from the ladle so it can be transported in two pieces.

OPERATING COSTS REDUCED WITH TM ALLOY STEEL CHAIN!

The growing use of TM Alloy Steel Chain is resulting in lower chain costs everywhere, according to the S.G. Taylor Chain Company of Hammond, Indiana. Special Analysis Alloy Steel and Taylor's unique chain-making methods assure a product that has twice the strength, twice the safety factor and many times the life of wrought iron chain.

These features plus the fact that TM Alloy Steel Chain is heat-treated and never requires annealing... its resistance to shock at all temperatures... its ability to withstand work hardness and grain growth add to the success of this chain. A complete line of slings, in a variety of sizes, with a choice of alloy steel attachments is available from stock. Two types of patented magnet chain assemblies are also available. TM Alloy Steel Chain is manufactured to customer's specifications as well. Contact your distributor today or write Dept. 4, S. G. Taylor Chain Company, Hammond, Indiana.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USE—
TM
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TAYLOR CHAIN
HAMMOND IND.
STRONGER
TM Alloy Steel Chain has twice the strength of wrought iron chain!
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On a size for size basis TM Alloy Steel Chain has twice the safety factor of wrought iron chain!
LASTS LONGER
This famous chain lasts five to fifteen times longer than wrought iron chain!
COSTS LESS
TM Alloy Steel Chain's greater strength and longer life means lower chain costs for you.

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A GREAT NAME IN
Chain SINCE 1873

S. G. Taylor Chain Co.
Dept. 5
Hammond, Indiana

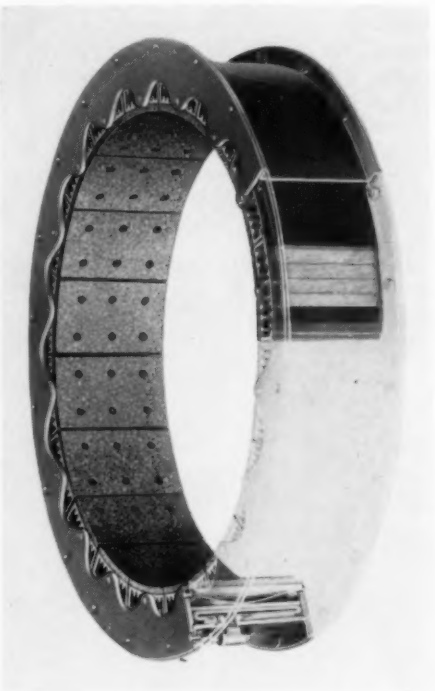
Rush free catalog on Alloy Steel Chain.

Name_____

Address_____

clutch. This completely ventilated clutch of the rigid type provides for transmission of power from the friction shoes through the torque bars to the metal side plates of the assembly.

Field tests of this new unit reveal that it is unmatched for heavy-duty service with high-starting loads and sustained slippage where generated operating heat lowers clutch efficiency and shortens operating life.



Unique design features found in this new air-operated clutch include: cooler operation inherent in drum clutch design plus isolation of the operating tube from the heat-generating friction surface; riveted, replaceable friction lining; and loose, expanding operating tube which can be replaced without removing clutch from shaft.

This new unit is manufactured in sizes ranging from 12 in. through 42 in. drum diameters with torque capacities ranging from 27,000 in. lb to 380,000 in. lb.

ROTARY PUMP

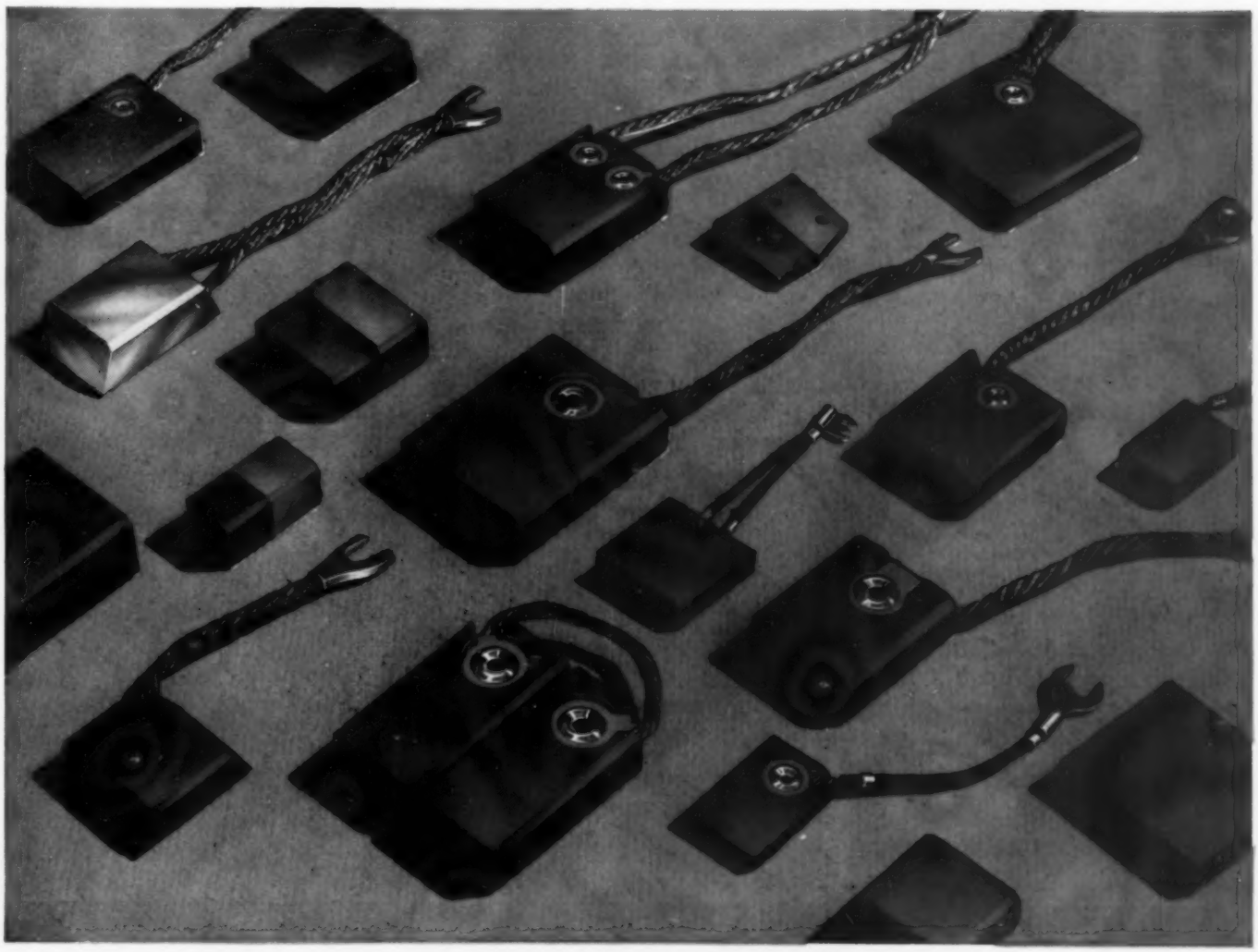
▲ A new rotary gear pump of simplified design is announced by the Sier-Bath Gear & Pump Co., Inc. According to the manufacturer, this simplicity makes possible high quality at low cost. Primarily for positive displacement of lubricating liquids, the "Hydrex" Pump will handle fluids and semi-fluids, 32 ssu to 250,000 ssu. Capacities are 1–500 gal per min.; 300 psi for continuous duty, 500 psi for intermittent service.

The simplicity of the "Hydrex" is

BUY USG BRUSHES

Try USG Brushes. They will solve those tough application problems for you. • Complete manufacturing facilities, plus continuous research and engineering make USG Brushes and Contacts the best you can use on all rotating electrical equipment. • USG BRUSHES can do a *better* job for you . . . Let us arrange a performance test to prove it.

Write today for 40-page catalog giving complete information on standard USG grades.



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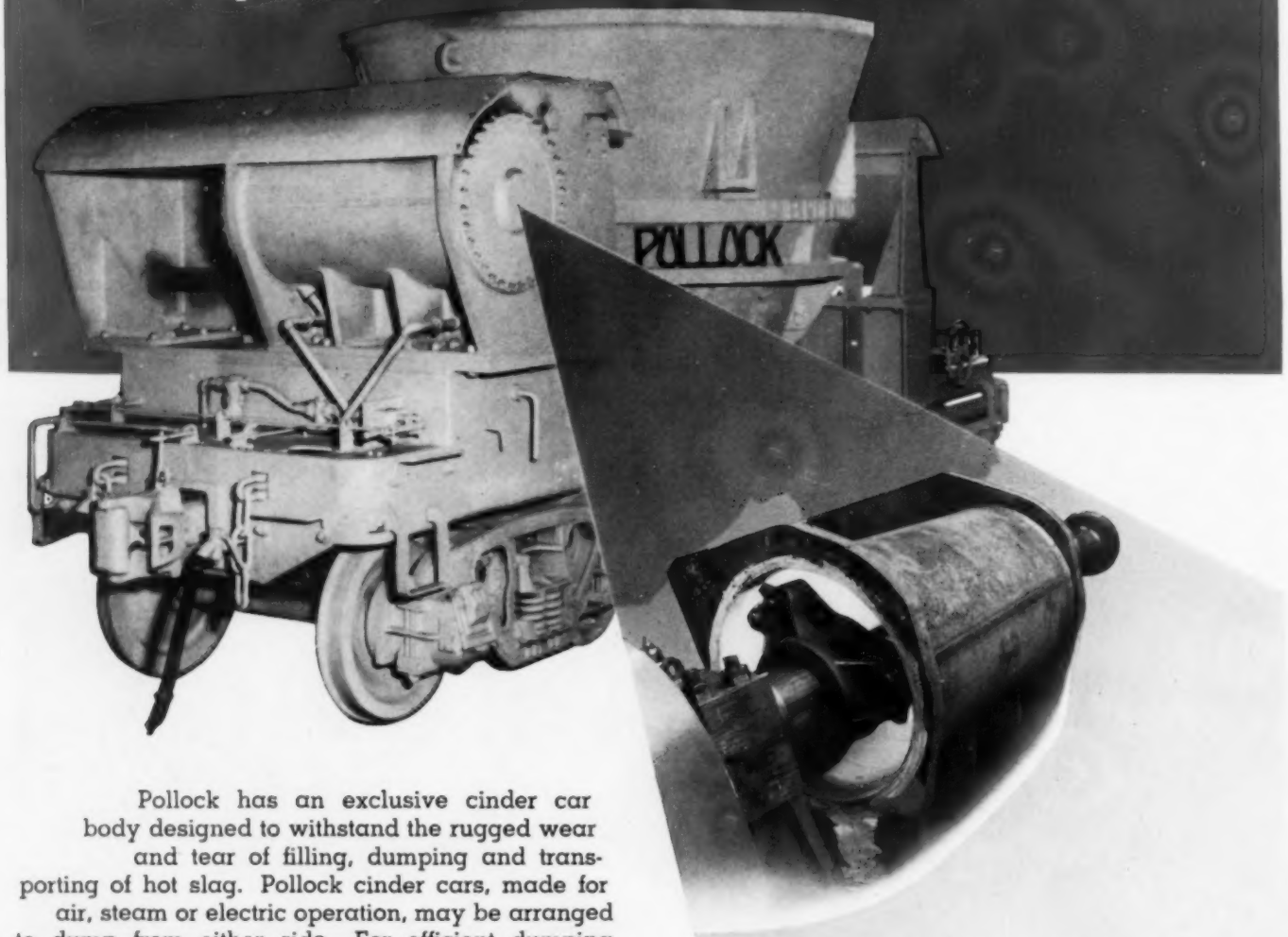
meeting POLLOCK cinder cars "specs" requires POLLOCK special facilities



Pollock has an exclusive cinder car body designed to withstand the rugged wear and tear of filling, dumping and transporting of hot slag. Pollock cinder cars, made for air, steam or electric operation, may be arranged to dump from either side. For efficient dumping, Pollock cylinders provide ample power which results from close-tolerance boring and finishing on a special Pollock machine. This is another example of where Pollock specifications are high because the company has special facilities to meet tough requirements. The major steel plants all over the world use Pollock cars, so why not have Pollock's expert engineers apply their experience to your cinder handling requirements.

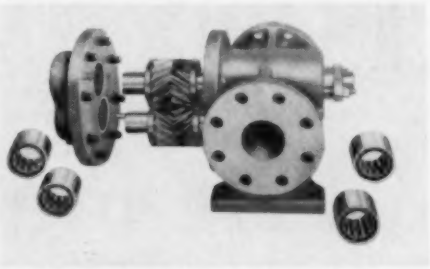
This Pollock special machine will bore to close tolerances cylinders from 16 to 36 inches in diameter and up to 4½ feet long.

POLLOCK
Since 1863

THE WILLIAM B. POLLOCK COMPANY
YOUNGSTOWN, OHIO

STEEL PLATE CONSTRUCTION • ENGINEERS • FABRICATORS • ERECTORS
BLAST FURNACES • HOT METAL CARS AND LADLES • CINDER AND SLAG CARS
INGOT MOLD CARS • CHARGING BOX CARS • WELDED OPEN HEARTH LADLES

indicated by: only two castings are used — for the body and the head; there are only two moving parts — the two rotors; no inner races are needed in the bearings as the shafts are hardened and ground at the bearings; only one stuffing box is used (under suction pressure).



The high quality of the "Hydrex" is indicated by the above plus: rotors are precision made gears; pumps are hydraulically balanced axially; shaft is hardened and ground at stuffing box, which minimizes wear; heavy duty roller bearings are used; all connections over 2 in. are flanged; all machined surfaces are ground for easier piping and aligning.

RING SEALS

▲ Simplicity of design is an important feature of Garlock's new "O" ring mechanical seals for rotating pump shafts. The small number of parts affords easy manufacturing adaptability of this improved seal to withstand any liquid, whether mild, harmfully corrosive or extremely hazardous, on rotating pump shafts.

These "O" ring seals are designed to provide leakless operation of rotary shafts on centrifugal pumps handling chemicals, petroleum products, edible liquids, pulp liquors, and many other liquids. They are furnished in Type O, an unbalanced seal for pressures up to 200 psi, and in Type OB (illustrated), a balanced seal for pressures up to and over 1000 psi. Both types can be supplied with single spring or multiple spring, and in either pin-drive or sleeve-drive construction.

Type O seals are furnished for packing spaces 5/16 in. and larger. In

THIS PICTURE TELLS A STORY of a new cost-cutting opportunity for steel mills

Note the ready accessibility of each item of steel in this storage yard of a well-known steel mill. It's this availability of materials that's one of the prime advantages of the ROSS STRADDLE CARRIER handling method . . . an advantage, unmatched by any other method, that eliminates delays, lowers costs and increases the production efficiency of the mill.

ROSS STRADDLE CARRIERS, heart of the Ross unit-load handling system, are built to handle 45,000-pound concentrated loads on around-the-clock schedules in the roughest, toughest steel mill service . . . to put those loads *where* wanted *when* wanted.

Your mill, too, can profit by this modern, flexible mass handling system. Get in touch with Ross today for the complete details.

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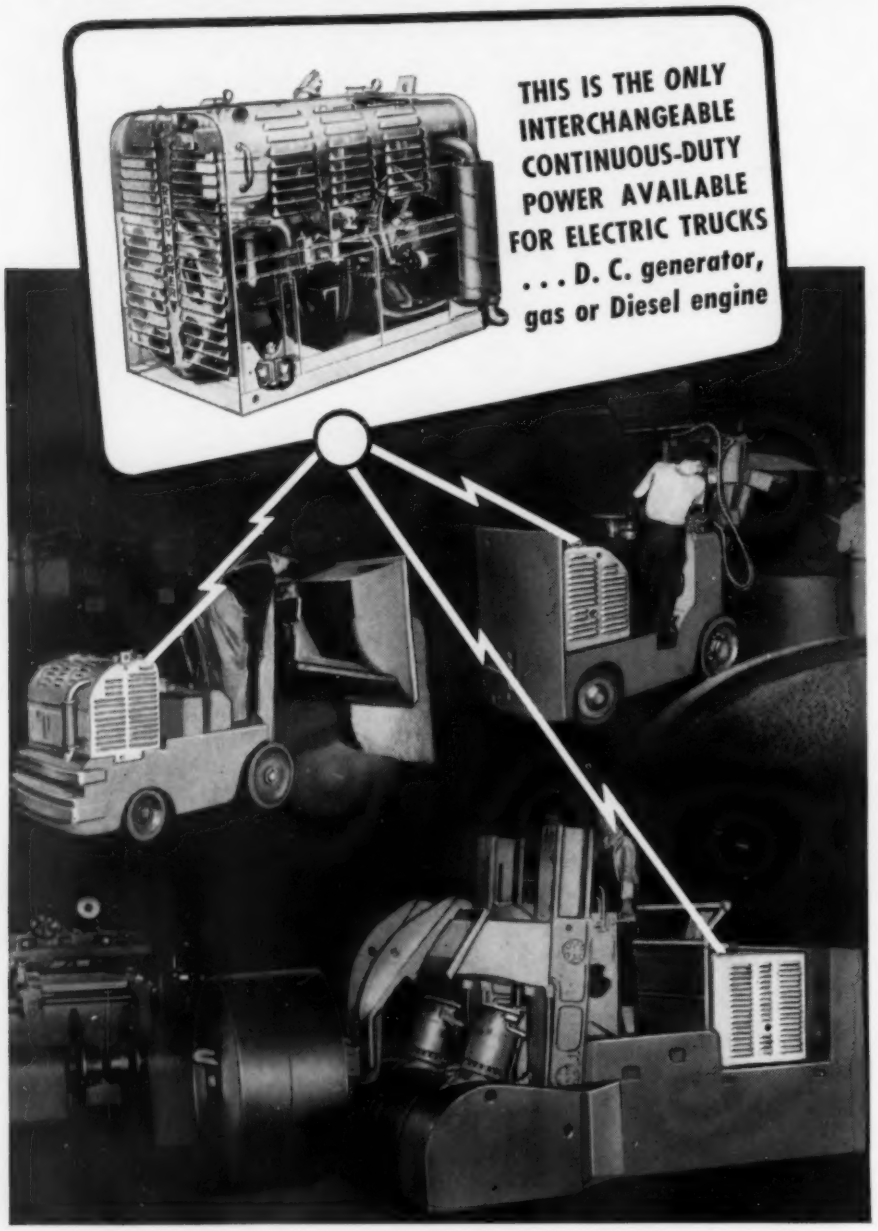
THIS IS THE ONLY INTERCHANGEABLE CONTINUOUS-DUTY POWER AVAILABLE FOR ELECTRIC TRUCKS . . . D. C. generator, gas or Diesel engine

Only Ready-Power Drive gives electric trucks the stamina that means *full power all the time!* With no limit to hours of service, Ready-Power-equipped trucks handle the toughest jobs at lowest costs per ton-mile. Gas-electric and Diesel-electric models are available for ALL sizes of electric trucks.

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Manufacturers of Gas and Diesel Engine-Driven Generators and Air Conditioning Units; Gas and Diesel-Electric Power Units for Industrial Trucks

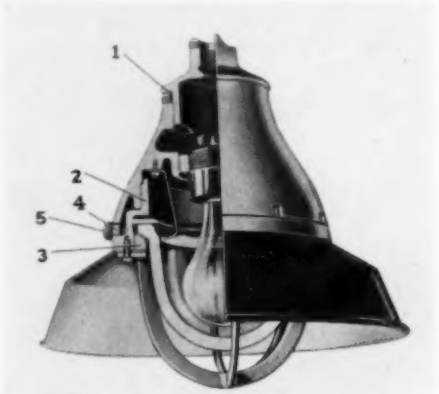
some cases, Type O seals can be made for ¼ in. packing space. Type OB seals are furnished for packing spaces ⅜ in. and larger.

The "O" rings are available in "Teflon," Buna-N, Neoprene, or Silicone. The metal parts contacting the liquid can be furnished in any suitable metal.

NON-EXPLOSIVE UNIT

▲ A new explosion-proof lighting fixture has just been introduced by the Crouse-Hinds Co. The new design, one of Crouse-Hinds' "EV" series explosion-proof industrial lighting fixtures, is easier to install and relamp because it is lighter and better sealed. In addition, it has 5 to 10 per cent greater lighting efficiency than previous models.

Prime reason for designing the new fixture (see cutaway drawing) was to improve its threaded connections in order to prevent liquids, vapors or dirt from entering bulb and receptacle areas. This was accomplished by three male threadings located at each of three points: (1) near the rim of the hood, (2) where hood and globe-holder are joined together and at (3) where globe retaining ring and cushioning



gasket are seated against the globe. Two of these threadings are inside the hood, the other, around the inside of the globe holder. Each male threading is seated securely against a corresponding female threading. A rubber O-ring gasket (1) has been inserted above the threaded fitting at the top of the hood to seal off the receptacle compartment. One-piece assembly of globe, holder, guard and reflector is threaded high up inside of the hood (2) to prevent leakage into the lower section of the fixture.

These features were the result of two years study by Crouse-Hinds' engineers. Other improvements were perfected at the same time, in spite of the fact that the company already

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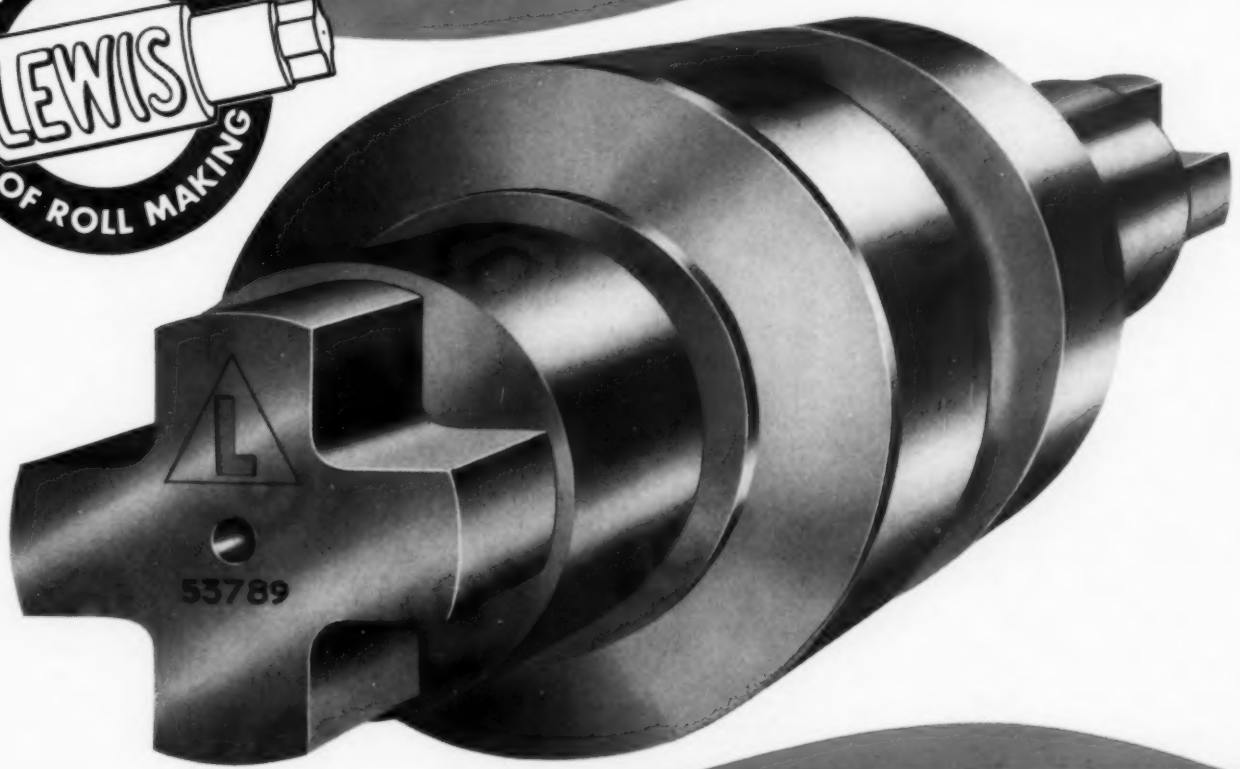
OVER 90 YEARS LEWIS OF ROLL MAKING



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- LEWIS "X" AND "XA" ROLLS
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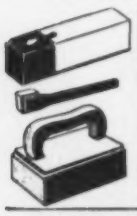
- PLAIN CHILLED IRON ROLLS
- SPECIAL TUBE MILL ROLL
- ATLAS, ATLAS "B" AND ATLAS "X" ROLLS
- MOLYBDENUM CHILLED IRON ROLLS

may we have the opportunity of studying your requirements and submitting our recommendations

ROLLS DIVISION OF BLAW-KNOX COMPANY, PITTSBURGH, PA.

Keeps motors running like new... The easy, fast way to restore commutators and slip rings — WITHOUT DISMANTLING! — Substitutes low-cost prevention and correction for high-cost repair and rebuilding — COSTS LITTLE, SAVES A LOT.



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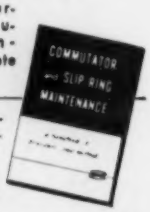
Refinish commutators and rings to like-new condition even when ridged, scored or burned.

MICA UNDERCUTTERS
Stop sparking — help commutation — prolong brush life. For all sizes of commutators.

PRECISION GRINDERS
For more than surface smoothing—under machine's own power. Accurate to .001".

FLEXIBLE ABRASIVE
Cleans and burnishes commutators. Non-dusting. Complete size range.



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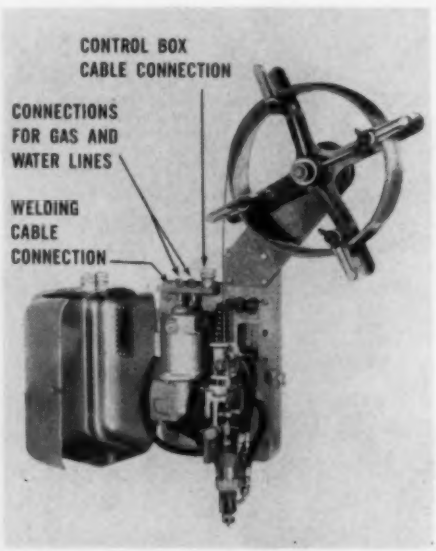
has a fixture design that was perfectly safe for use in hazardous locations where it must operate at a temperature below the ignition temperature of the gas-air or vapor-air mixture surrounding it. For example, notches in the hood and globe holder (4) enable the globe holder to be loosened easily with a screw driver, even after it has been exposed to dirt-laden air or corrosive vapors for a prolonged period of time. Finally, a large knurled thumb screw (5) sets between these notches to lock the holder into place.

All types of reflectors are available on 100, 150, 200, 300 or 500-watt fixtures. Also available for use with the new fixture are the following accessories: breather, three contact receptacle, frosted globe or half-shade.

VOLTAGE CONTROL UNIT

▲ A new, lightweight sigma (shielded inert gas metal arc) welding machine features arc voltage control. This feature eliminates all welding problems that are due to a fluctuating arc voltage. Electronic controls maintain the proper balance of welding conditions by instantaneously speeding up or slowing down welding wire feed rate as required by changing arc conditions. Smooth, uniform welds are made as a result of this precise control over welding variables.



Voltage control was developed for sigma welding by Linde Air Products Co., a division of Union Carbide and Carbon Corp. The electronic control unit does not get in the way of the welding operator or other work going on in the shop. And it does not have to be moved with the welding machine from one job to another. It can be permanently mounted anywhere, as long as it is properly connected to the welding machine.

The machine is easy to operate — it practically operates by itself. All that the welding operator needs to do is preset the required voltage, and throw the starting switch. A retract starter built into the electronic control unit does the rest. It causes welding wire to feed down until contact is made with the work. Then the wire automatically retracts, drawing an arc; then the wire reverses direction a second time, and feeds down, maintaining the preset arc voltage.

SAFETY AWARD

▲ Dravo Corp. has received the National Safety Council's highest award for employee safety. J. E. Goble, president of National Tube Division of United States Steel Corp., and president of the Western Pennsylvania Safety Council, Inc., presented the Award of Honor to Dravo president Carl B. Jansen.

Only a handful of company-wide Awards of Honor are given annually by the National Safety Council. They are presented for completion of three million accident-free manhours, or for a significant improvement in a firm's accident record during a one-year period.

Dravo won the award for its 1952 accident prevention record which was 50 per cent better than its previous three-year average and the three-year average of the industry. During 1952, Dravo experienced only one lost-time accident for every 161,351 manhours worked, according to G. O. Griffin, Director of Safety for the corporation. It was the second best year for safety in the company's 62-year history.

It was one of the first company-wide Awards of Honor ever given by the National Safety Council to a firm in the heavy construction industry.

In addition to the company-wide award, Dravo's Neville Island shipyard also has won first place in the National Safety Council's Marine Section safety contest. The Neville Island record was best of 15 private heavy shipyards entered in the contest.

Dravo's Wilmington, Del. shipyard was tied for first place in the contest among light shipbuilding yards.

CONTINUOUS STRIP ANNEALING in DREVER VERTICAL FURNACES

Saves Time • Reduces Cost

Outstanding PRODUCT

A Uniformity annealed strip from edge to edge and end to end of coil

B Uniform Physicals throughout the coil

C Clean, Lustrous Surface that electro-tins uniformly

D Stickers and "Dog Ears" eliminated

E Users of Continuous Annealed Strip report longer die and shear life

Drever Company has pioneered this striking improvement in Continuous Annealing Furnaces for Tin Plate Strip, Silicon Strip, Blue Plate and other strip products. We predict all major steel mills will anneal by this method. Why don't *you* do it now?

Equipment can be specified for output up to 30 tons per hour of 30″ wide x .010″ thick low carbon steel. Several sizes are available, in any width.

Furnace illustrated produces Tin Plate and Blue Plate. The shift-over from the Bright Surface required for Tin Plate to the uniformly applied, accurately controlled tight oxide coating required for blue plate is rapidly and easily made.

Installations backed by staff of Engineers and Metallurgists of sixteen years experience in Continuous Annealing of Low Carbon Strip.

Outstanding DESIGN

1 Speeds up to 1000 feet per minute

2 Controlled Strip Tension, excellent tracking

3 Controlled Heating and Soaking Time

4 Regulated Cooling Rate

5 Predictable Strip Temper

6 Cleaning in same line

7 Low Maintenance

8 Reduction in Floor Space

9 Reduction in Coil Inventory

10 Overall Saving in Annealing and Cleaning Costs

DREVER CO.
730 E. VENANGO ST.
PHILADELPHIA 34, PA.

Building up to a costly letdown...

OF COURSE YOU'RE NOT—OR AT LEAST NOT CONSCIOUSLY. But perhaps you are missing a bet here and there. The sketch is intended to remind you of the importance of building a sound lubrication structure — from the bottom up. We'd also like to remind you that a Gulf Sales Engineer can give you practical help on any of these individual phases of the lubrication problem. For additional information, write, wire, or phone your nearest Gulf office.

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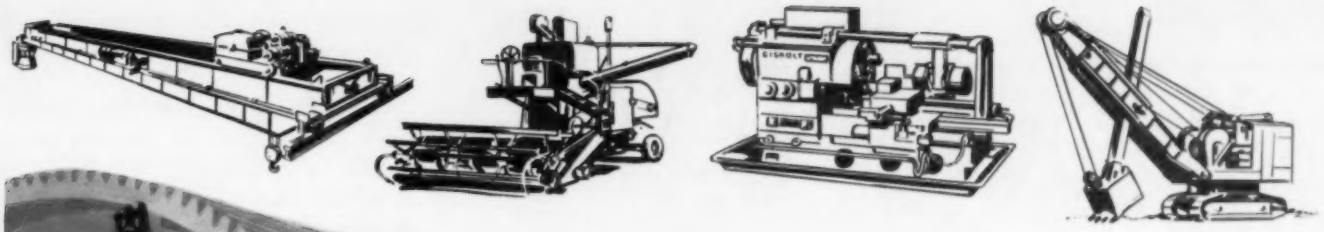
Pittsburgh 30, Pennsylvania

GULF SERVES INDUSTRY



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Send us your specifications for a prompt quotation on your requirements. Also write for Brochure "A Pictorial Trip Through Industrial" Bulletin No. 152-A.

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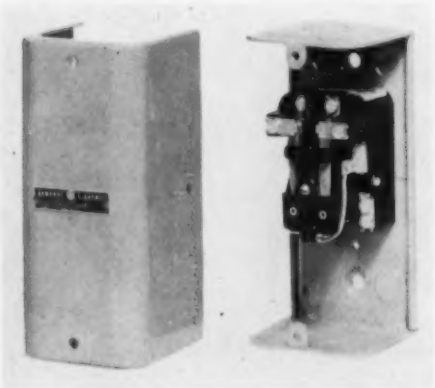
RELAY UNITS

▲ A complete new line of general purpose relays, featuring longer life and greater flexibility of application, has been announced by the General Electric Co.'s control department.

According to G-E engineers, operating life of the new relays has been greatly extended by use of a braided shunt and repositioning of the shunt to reduce tension and wear.

Use of the standardized open-form relays with conversion kits, which may be stocked separately, provides units with greater utility and permits reduction in inventory, the engineers said. Conversion units are available for metal and compound base back-mounting, base receptacle and relay jack-plug applications, and explosion-proof enclosures for dust tight and Class 1, Group D service.

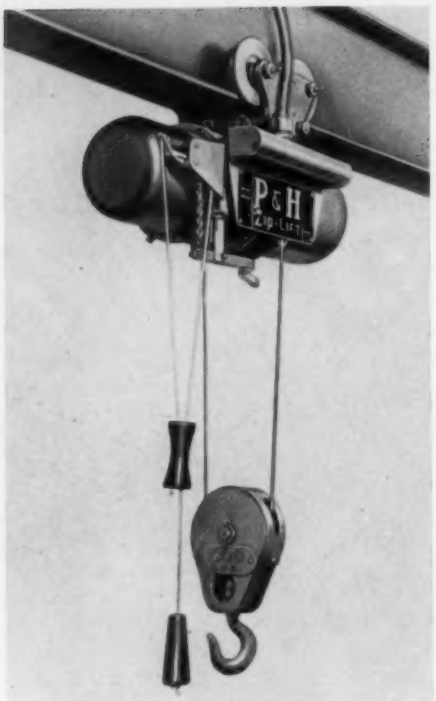


The new relays, designated as "CR2790-E," are rated from 6 to 300 volts; 60, 50, and 25 cycles plus d-c; and 10 amp continuous contact rating. Contact arrangements include — double-pole single-throw, double-pole double-throw, and single-throw double-break.

The relays may be used as starters for small a-c motors where motors have sufficient overload protection. They also are especially suitable for application in electronic equipment and air conditioners, where small space and long relay life are major factors, the company engineers said.

ELECTRIC HOIST

▲ A new model "Zip-Lift" electric hoist with rope control to sell for only $199.50 is announced by Harnischfeger Corp. The new hoist is actually a standard hoist designed to be operated with P&H's unique one-hand



rope control. It has all the features of the regular model.

P&H stresses the fact that the new hoist is guaranteed to operate continuously during intermittent usage for a period 25 per cent longer than the rated time limit. The new hoist is also designed with a weight-overload safety factor of five times the rated capacity.

As in all P&H hoists, wire rope hoisting will be used because of its wider range of side pull and greater safety from hidden wear. Other regular P&H features will be included such as double brakes, oil bath lubrication, fully-enclosed construction, and greased packed motor bearings. The new hoist comes in two models with lifting capacities of 500 and 1000 lb. Hoisting rates are 25 and 13 fpm. Both models are available with 12 ft and 18 ft lift.

A simplified guide to proper gas composition in heat treating furnaces is provided by a dew point recorder, which detects the moisture content of gas atmosphere. Made by Foxboro Co., the recorder monitors a continuous sample of the gas, permitting the operator to make accurate generator adjustments and hold the moisture content within desired operating limits.

As installed in a number of metal treating plants, the instrumentation consists of a two-pen recorder, a "Dewcel" power unit and two sensitive elements. A minute flowing sample of gas from the furnace or the exhaust is piped to a sampling chamber where the measuring element senses the dew point temperature to within ± 1 C.

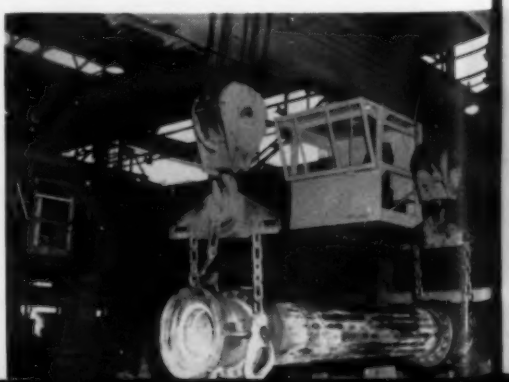
A second pen records gas ambient temperatures, which must be roughly within a range related to the dew point measurement. High gas sample temperatures can generally be brought within the working range by lengthening the pipe run between the sampling point and the chamber, or by use of a small cooling water coil heat exchanger.

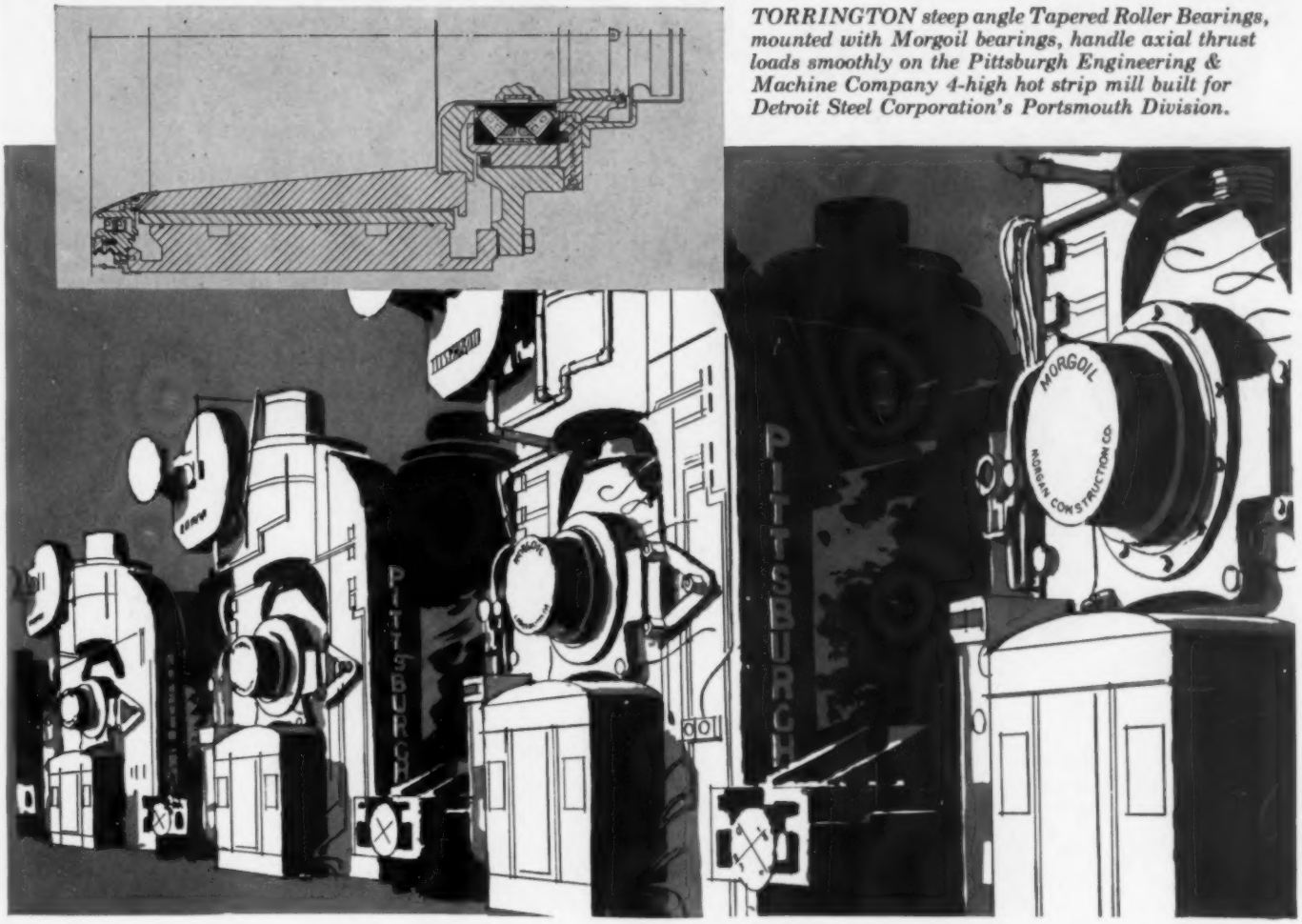
Key unit in the system is the humidity sensitive Dewcel element which provides a laboratory standard of measurement even in severe industrial service. Ordinary dust and contamination have no effect on its operation. It provides a continuous record in dew point; responds rapidly to changes in moisture content.

CRANE CAB COOLER

▲ Tar fumes arising from dipping tanks in the casting building of a foundry created an annoying situation for the hot-metal crane operators of a southern foundry. The fumes contain acridine, which causes headache, eye soreness and inflamation of the mucous membranes. Also of considerable nuisance was sand, dust and steam in the atmosphere as well as the excessively high temperature present at the crane level.

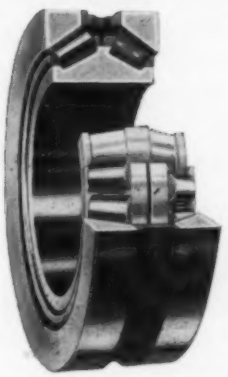
To protect the operator against these perception dulling hazards the crane cab was enclosed and fitted with a sloping front window which permits the operator to lean forward and get the best possible working view of the floor below. A Dravo crane cab cooler, mounted on the bridge above, furnishes filtered, odor-free and cooled air to ventilate the cab. Working in a comfortable atmosphere of 80 to 85 degrees F in summer and 68 to 72 F in winter, the operator is no longer affected by distracting conditions and remains alert to the dangers involved with handling molten metal.





TORRINGTON steep angle Tapered Roller Bearings, mounted with Morgoil bearings, handle axial thrust loads smoothly on the Pittsburgh Engineering & Machine Company 4-high hot strip mill built for Detroit Steel Corporation's Portsmouth Division.

For peak efficiency and lower costs!



TORRINGTON Bearings are solving an increasing number of the problems posed by the heavier loads and higher speeds of today's steel mill equipment.

They carry the heavy thrust loads encountered in the high speed of the 4-high rolling mills. Engineered to meet these conditions, the steep angle construction guarantees maximum thrust capacity.

There are TORRINGTON Bearings to handle any combination of thrust and radial loads. They are available in a complete range of types, including cylindrical, tapered and spherical roller bearings.

Precision-ground races and rollers assure minimum friction, high capacity and long service—giving you maximum return for your bearing dollar.

It pays—to use TORRINGTON BEARINGS!

THE TORRINGTON COMPANY
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TORRINGTON TAPERED ROLLER BEARINGS

Spherical Roller • Tapered Roller • Cylindrical Roller • Needle • Ball • Needle Rollers

"... More than 6,000 of our employees are now participating ..."

MELVIN H. BAKER
Chairman of the Board, National Gypsum Company

"The Payroll Savings Plan for Bonds provides a convenient and profitable way for America's wage earners to save. Millions of Payroll Savers have become proud owners of homes purchased with Bonds bought this way. It also helps our national government with its problems of managing the public debt. We in National Gypsum urge the stimulation of the Payroll Savings Plan and are proud to report that more than 6,000 of our employees are now participating."

Here's another success story of a person-to-person canvass:

In the Wahoo (Nebraska) ordnance plant of the National Gypsum Company, employee participation in the Payroll Savings Plan was a very low 1.73%.

In September of last year, with the whole-hearted encouragement of top management, the 3,000 employees of Gypsum's Ordnance Plant organized to conduct a person-to-person canvass to put a Payroll Savings Application Blank in the hands of every employee.

90% of the employees signed up in the opening days of the campaign. By September 12th, employee participation was 93.7%. On October 2nd, participation was almost 97%—and still going up.

To quote from National Gypsum's printed report of the Payroll Savings campaign:

• "Did we use fancy charts! Did we use advertisements? Did we have long-winded meetings. Did we give prizes for production? The answer is No! We put the proposition squarely to the people, and we reported to the people once a week in bulletin form to let them know where they stood in relation to other departments as well as to the plant total. Once the spirit of competition and teamwork caught fire, once it became a matter of personal pride; a successful conclusion was only a matter of time and effort."

Justifiably proud of its sponsorship of the Payroll Savings Plan and the 97% enrollment of its employees, National Gypsum Company prepared a very interesting folder, "Bombs and Bonds for National Defense. The Savings Bond Program of the National Gypsum Company." Savings Bond Division, U. S. Treasury Department, Suite 700, Washington Building, Washington, D.C., will be glad to send you a copy. Read how easy it is to build *your* Payroll Plan to 90% or more participation.

The United States Government does not pay for this advertisement. It is donated by this publication in cooperation with the Advertising Council and the Magazine Publishers of America.

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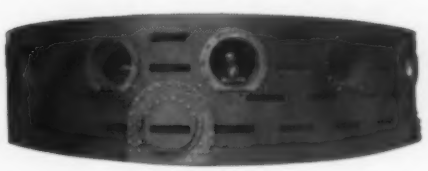

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Bars	Gears
Tubes	Castings
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Tempering	Soldering
Forging	Enamel Baking
Tin Fusion	Melting
Galvanizing	Preheating
Reheating	Mold Curing

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Development • Design • Manufacture

Type MD
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Write for Bulletin 410—Dept. E

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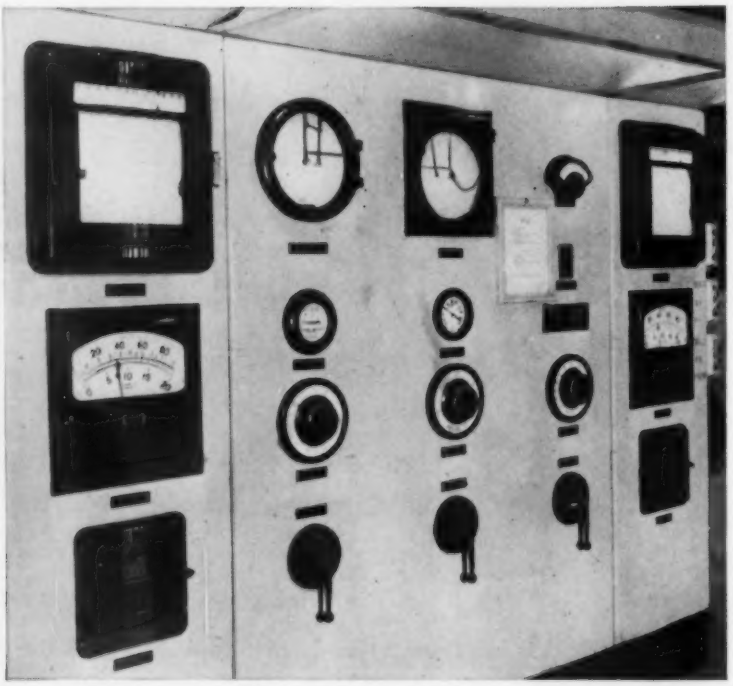
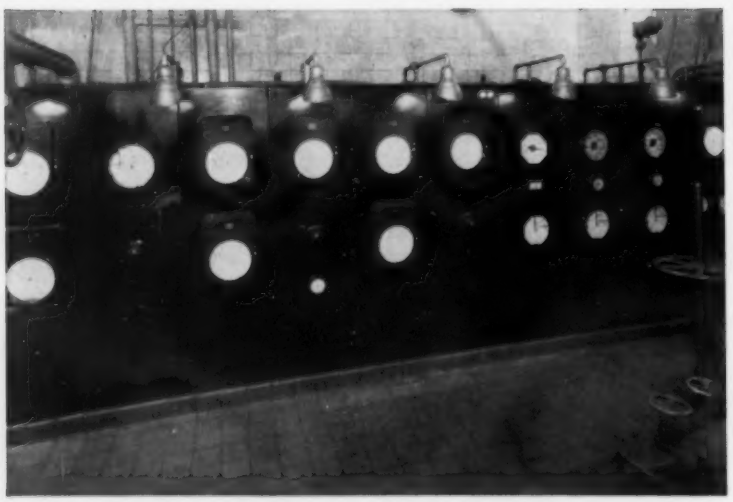


Askania controls for 2-zone heating furnace.

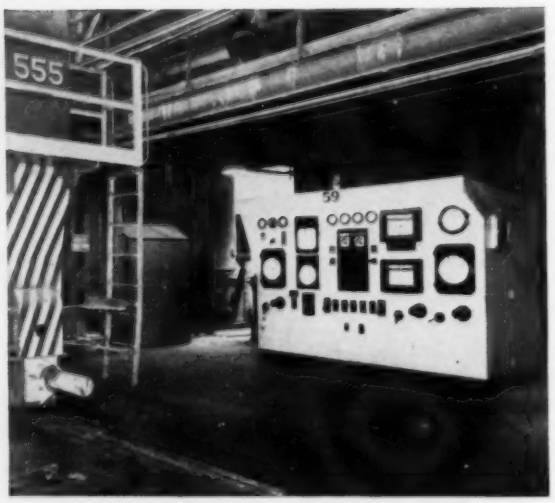
One of Askania's 20-year users is this large eastern steel plant. More than 200 Askania regulators are used in different applications throughout the plant. These panels house a few of them.

The men in this plant are typical of the steel men who know and trust Askania. They know from two decades of experience that Askania controls are built for continuous duty under the most severe conditions. They know that Askania controls are simple and straightforward, with no mumbo-jumbo.

Askania automatic controls are first in the steel industry. Write for bulletin 139; it tells about Askania controls for pressure, flow, and proportioning.



Askania automatic controls for coke ovens.



Askania automatic controls for open hearth furnace.

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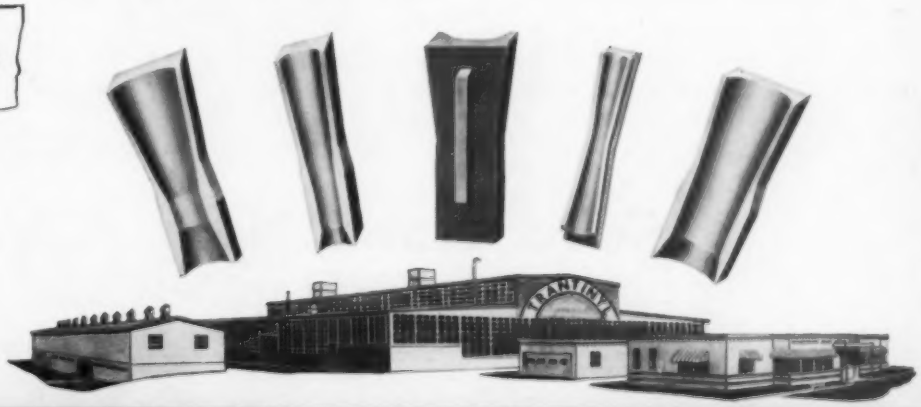

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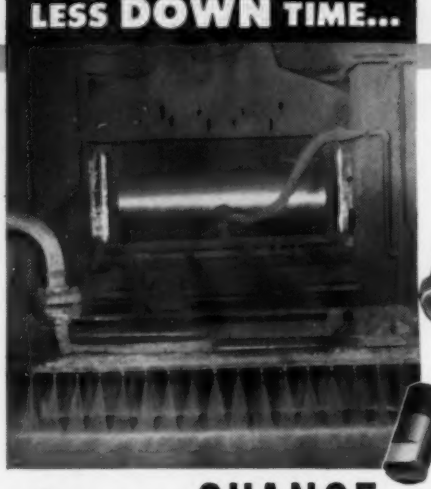

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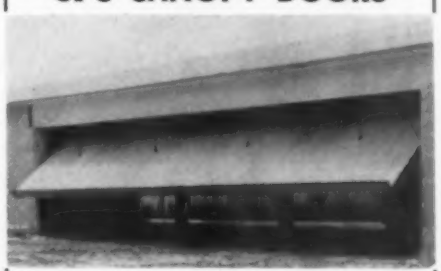

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Book Reviews . . .

▲ "Stahldraht" (Steel Wire), second edition, by A. Pomp, 335 text pages 6 in. x 9 in., 368 illustrations, 22 tables, was recently published by "Verlag Stahleisen," Dusseldorf, Germany, price 38 German Marks. Approximately 12 years have elapsed since the publication of the first edition of this well known book, which then had 244 text pages and 265 illustrations. Since the first publication, many improvements have been made in the production of steel wire. The author has skillfully woven them into the framework of the book.

"Stahldraht" starts with the wire rod, as it comes from the mill, and discusses the effects of imperfections in the rod upon the quality of the finished wire. It then describes and illustrates "ALL" stages of wiremaking and ends up with methods of testing the finished product. The effect of each step on the properties of the end-product is discussed. As may be expected, wiredrawing, annealing, and patenting take up more than half of the book, but many other steps, such as pickling, hardening, straightening, polishing, and coating with zinc or with tin are described and illustrated in detail. Even extraneous subjects, such as for instance disposal of pickling wastes, are included.The manufacture of wire-goods (springs, fences, sieves, nails, barbed wire, coat-hangers, etc.) is not described in this book. Reviewed by W. Trinks.

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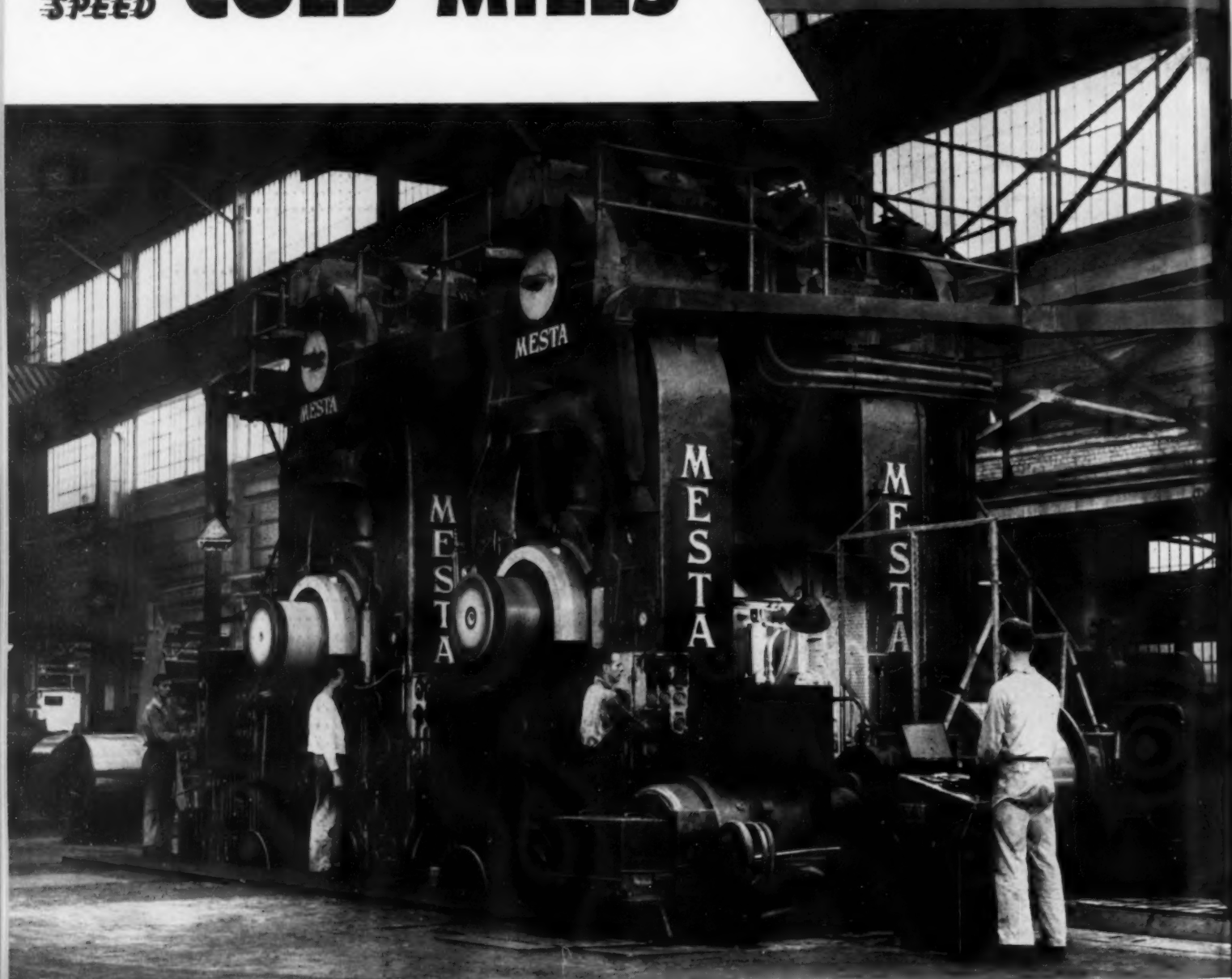
MESTA

HIGH-SPEED COLD MILLS



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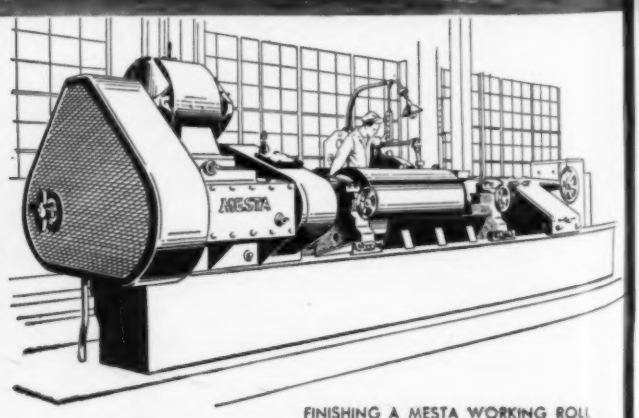

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No. 140

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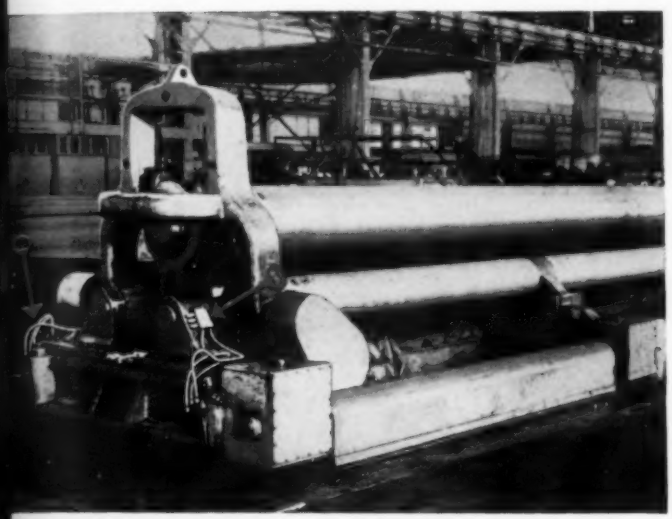

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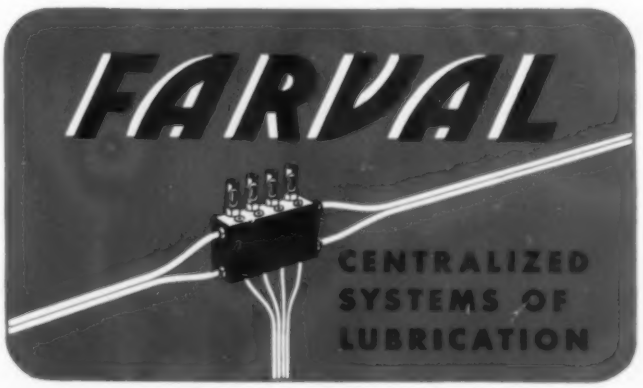
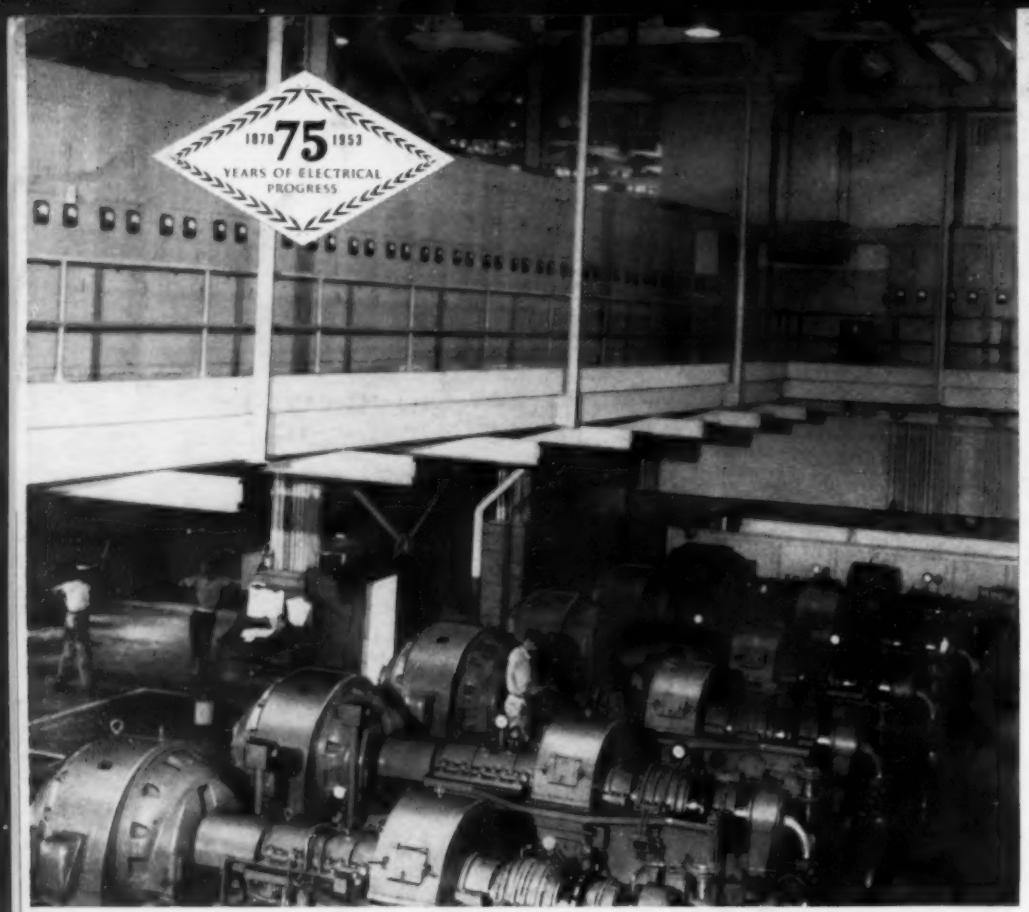
	Lbs./yr. lube. 62 points	Hrs./yr. lube. 62 points	Annual Cost @ $1.50/hr. 62 points
GREASE GUN	20,592 lbs.	717 hrs.	$1,075.00
CENTRALIZED SYSTEM	5,304 lbs.	15 hrs.	$ 22.50
ANNUAL SAVINGS EFFECTED BY FARVAL	15,288 lbs.	702 hrs.	$1,051.50
COMBINED SAVING (LABOR AND LUBRICANT)			$2,579.50

AND IN ADDITION, FARVAL SAVES BEARING EXPENSE AND PRODUCTION TIME

Reports of lubrication engineers show lubrication by grease gun takes .747 minutes per point—to clean dirt from nipples, grease, move from point to point, and refill gun. With Farval it takes only 15 minutes every fourth day to refill Farval reservoir. In addition, Farval saves 3 pounds of each 4 of lubricant used by other methods.





G-E LIMITAMP controls operation of synchronous and induction motor drives—will protect equipment under short-circuit conditions as high as 250,000 KVA.

G-E Limitamp Control—

Provides Greater Safety At High Voltages

G-E Limitamp is a high voltage motor starter providing interrupting capacity up to 4800 volts . . . gives you quick, silent short-circuit protection for motors up to 2250 hp.

Heavy duty air-break contactors with improved arcing structure permit a rapid duty cycle for millions of operations . . . require little maintenance.

High interrupting capacity plus fast-acting, specially developed EJ-2 fuses, (which limit fault current to less than ¼ cycle,) provide complete motor protection . . . prevent costly shutdowns.

For safety of maintenance personnel high and low voltage compartments are separated by a steel barrier. Mechanical door interlocks assure motor circuit interruption before the fuse compartment door can be opened.

G-E engineers study your requirements . . . design all components into a co-ordinated "package" that will give you adequate interrupting capacity for your system.

G-E Limitamp controls are delivered totally assembled, ready for service and need only be put in place, the leads connected, fuses inserted . . . the control is ready to operate.

For complete information contact your G-E Representative, or write for Bulletin GEA-5409A, General Electric Co., Sec. 781-3, Schenectady 5, N. Y.

MAINTENANCE IS EASY—for example: are sh can be removed quickly, contact tips inspected, your Limitamp control is right back in operat

SIMPLE TO OPERATE—G-E Limitamp control p mits pushbutton operation for manual starting stopping while meters provide a quick check on lo

FUSES ARE EASILY REPLACED—when the fu swings forward on its hinge, it is easily lifted o and quickly replaced with the help of a switch ho

You can put your confidence in—

GENERAL ELECTRIC